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AUTHOR	Whitney, Terry A.
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ABSTRACT

This curriculum guide contains the technical information and tasks necessary for a student (who has already completed basic drafting) to be employed as an architectural drafter trainee. The curriculum is written in terms of student performance using measurable objectives, technical information, tasks developed to accomplish those objectives, and criterion-referenced instruments for uniform measurement of students' performance against the stated criteria. The guide is activity oriented with emphasis on commercial applications. It contains 11 units of instruction, each including some or all of the following: objective sheet, suggested activities for the teacher, assignment sheets and written test with answers, unit evaluation form, teacher supplements, transparency masters, information sheets, assignment sheets, and student supplements. Units cover the following topics: introduction to architectural drafting; architectural building materials; site conditions; introduction to working drawings; section and detail drawings; structural systems; architectural dimensioning; plumbing systems; heating, ventilation, and air conditioning systems; electrical systems; and presentation techniques. A glossary contains 322 technical terms. Supplementary materials for teachers include information on using the guide, academic and workplace skills classifications, competency profile, instructional/task analysis, related academic and workplace skills list, and 19 references. (KC)

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COMMERCIAL APPLICATIONS

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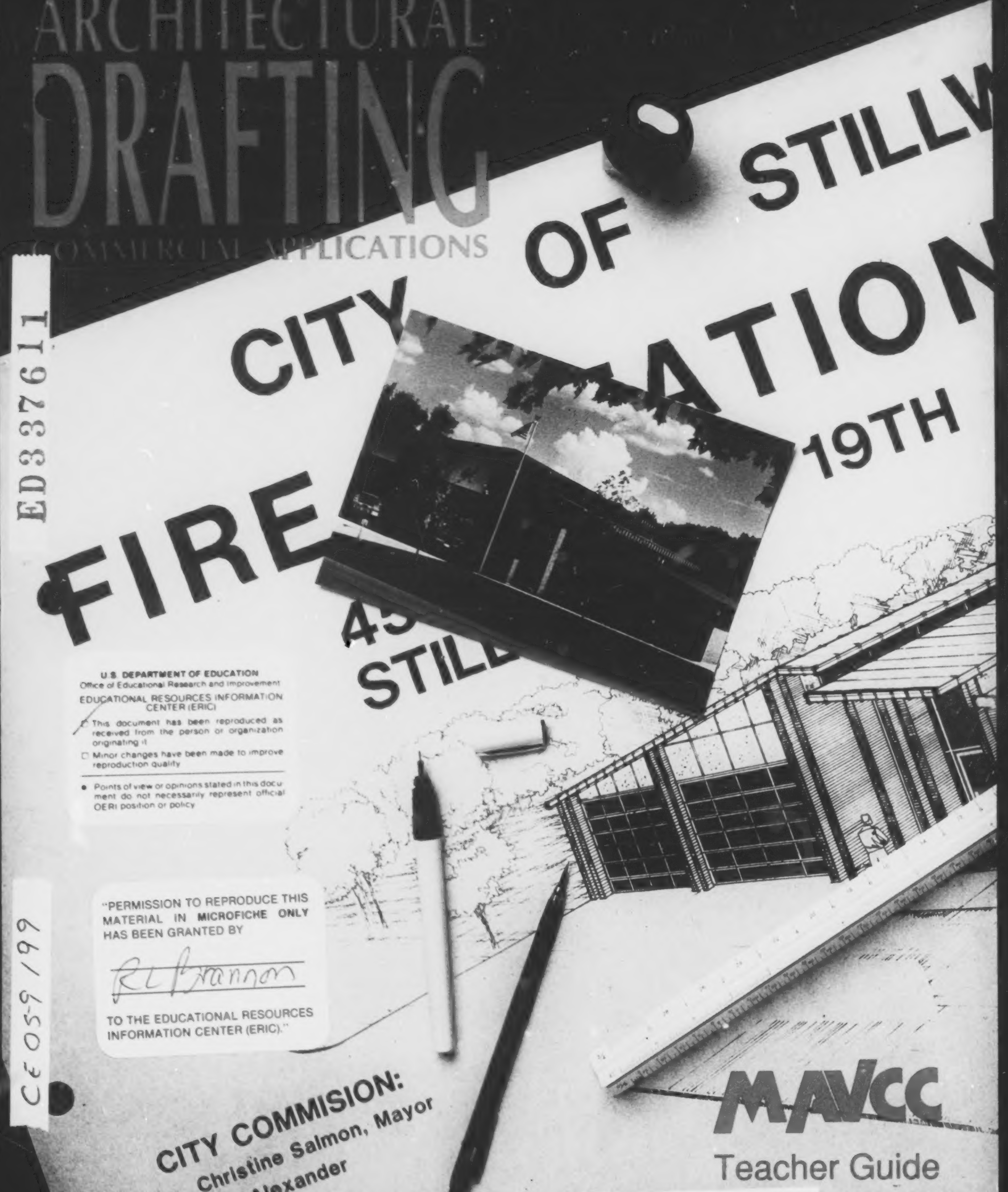

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MAVCC

Teacher Guide

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Architectural Drafting: Commercial Applications

Written by

Terry A. Whitney, Drafting/CAD Instructor
Boulder Technical Education Center, Boulder, Colorado

Project Coordinated by

Sue Buck, Curriculum Specialist
Mid-America Vocational Curriculum Consortium, Inc.

Developed by

The Mid-America Vocational Curriculum Consortium, Inc.

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Architectural Drafting: Commercial Applications

Teacher Edition

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Foreword

Architectural Drafting: Commercial Applications is part of a series of instructional materials on drafting developed by the Mid-America Vocational Curriculum Consortium. This publication is based on the assumption that the student has completed *Basic Drafting*. It contains the technical content and tasks necessary for a student to be employed as an architectural drafter trainee. Additional instructional materials have been developed for *Mechanical Drafting, Pipe Drafting, Electronic Drafting*, and *Civil Drafting*.

Architectural Drafting: Commercial Applications is written in terms of student performance using measurable objectives, technical information and tasks developed to accomplish those objectives, and criterion-referenced instruments for uniform measurement of the student's performance against the stated criteria. This publication is activity oriented with emphasis on commercial applications. Upon completing the assignments in the publication, the student should have developed an outstanding portfolio to present to prospective employers.

The success of this publication is due to the capabilities of the people who worked on its development. The technical committee, the writer and the curriculum specialist brought with them the technical expertise and the perseverance to develop a publication that will become a vital part of the teaching/learning process in architectural-drafting classes.

As with any MAVCC publication, the teacher must take the instructional materials and (1) localize to fit the community and industry needs, (2) supplement to match your teaching techniques, (3) personalize to meet each student's learning style and needs, and (4) motivate. These areas have been left to the individual teacher to expand and implement. MAVCC has been able to provide a working set of plans for a day-care center to supplement the instructional materials and provide an example for teacher and student.

Architectural Drafting: Commercial Applications will allow students to be better prepared to be effective members of the work force. If there is anything we can do to help this publication become more useful to you and your students, please let us know.

Sylvia Clark, Chairman
Board of Directors
Mid-America Vocational
Curriculum Consortium

Jim Steward
Executive Director
Mid-America Vocational
Curriculum Consortium

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The contents of this publication were planned and reviewed by the following members of the Mid-America Vocational Curriculum Consortium architectural-drafting committee:

Lanny Auringer
Rysavy, Hartman, Leither, Architects, Inc.
Sioux Falls, South Dakota

Danny Cowart
Tri-County Area Vo-Tech School
Bartlesville, Oklahoma

Bob Fredley, Jr.
Round Rock High School
Round Rock, Texas

Budd Langley
Johnson County Community College
Overland Park, Kansas

James Platt
Lakes Charles, Louisiana

Chuck Berendzen
Rolla Area Vo-Tech School
Rolla, Missouri

Doug Elting
Davis, Fenton, Stange, & Darling
Architecture Engineering & Interiors
Lincoln, Nebraska

Steve Pierce
Veenstra-Kimm
West Des Moines, Iowa

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Special thanks are extended to Rysavy, Hartman, Leither, Architects, Inc., Sioux Falls, South Dakota, for supplying the working drawings provided with this publication.

Use of Introductory Materials

Introductory materials are included in the teacher edition only and contain useful information to assist administrators and teachers in planning for instruction.

In addition to the general information—such as the table of contents, foreword, and acknowledgments page—information is included on the following:

1. **Use of this publication**—Explains the components of a unit of instruction and how they should be used as part of the teaching/learning process.
2. **Competency profile**—Provides a record of student performance for each task included in a unit of instruction. This profile becomes a part of the student's permanent records and should be utilized when directing the student toward employment opportunities.
3. **Instructional/task analysis**—Provides a quick review of contents of the publication; identifies cognitive (knowledge) skills and psychomotor (doing) skills addressed in each unit of instruction.
4. **Academic and workplace skills classifications and definitions**—Defines the basic-skill classifications used by MAVCC. Skill areas reflected by skill groups, subskills, and descriptions have been identified using *Workplace Basics: The Skills Employers Want*, developed by the American Society for Training and Development (ASTD) and the U.S. Department of Labor and adapted by MAVCC.
5. **Related academic and workplace skills list**—Classifies unit tasks (assignment sheets) according to related academic and workplace skills being reinforced.
6. **Reference list**—Provides a comprehensive list of resources used in the development of this publication.

As you use these materials, it is hoped that they will provide useful information to meet a variety of needs.

Use of This Publication

Instructional units

Architectural Drafting: Commercial Applications contains 11 units of instruction. Each instructional unit in a teacher edition includes some or all of the following basic components of a unit of instruction: objective sheet, suggested activities, answers to assignment sheets, answers to written test, unit evaluation form, teacher supplements, transparency masters, information sheet, student supplements, assignment sheets, and written test.

All of the unit components focus on measurable and observable learning outcomes. Teachers are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the teacher will help to determine the following:

- Amount of materials that can be covered in each class period.
- Skills that must be demonstrated.
- Amount of class time needed for demonstrations.
- Amount of time needed for student practice.
- Supplementary materials, including print and nonprint media and equipment and supplies, that must be ordered.
- Resource people who must be contacted.

Objective sheet (color code: white)

Each unit of instruction is based on performance objectives that state the goals for successful completion of the course. These performance objectives are stated in two forms: unit objectives, which state the expected performance of each student after completion of the unit of instruction, and specific objectives, which state what the student must do to reach the unit objective.

The objectives should be provided for students and stressed throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Teachers should prepare for each unit by deciding how each objective can best be taught.

Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When objectives are added, the teacher should remember to supply the needed information, assignment sheets, and written test items.

Suggested activities (color code: pink)

This component is included only in the teacher edition. The suggested activities assist teachers during the preparation stage of the teaching/learning process by providing an instructional plan, teaching suggestions, and a list of supplemental resources. The teacher should read the suggested activities before teaching the units and decide how each objective can best be taught. Time should also be allowed to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the teacher will vary according to the particular unit.

References used in the development of each unit are listed in the suggested-activities section, along with suggested supplemental resources that may be used to teach the unit. These materials can be used by the teacher to supplement her or his knowledge of the subject area or to help students with particular interests or objectives in the area covered.

Assignment and written-test answers (color code: pink)

Assignment-sheet answers and written-test answers are designed to assist the teacher in evaluation of student performances.

Unit evaluation form (color code: white)

This sheet provides teachers with a record of each student's performance on a unit of instruction. It includes space for assignment-sheet ratings, written-test scores, and teacher comments. The unit evaluation form is included in the teacher guide only, but may be duplicated.

Teacher supplements (color code: white)

This component is included only in the teacher edition. Teacher supplements are optional materials for the teacher to use. They have three purposes: to provide the teacher with higher level materials to stretch the advanced student, with remedial information or practice to assist the less-advanced student, and with state-of-the-art information in which the teacher may not have background or with information that is not readily available in other books. Some teacher supplements may be duplicated for student use and are marked accordingly.

Transparency masters (color code: white)

Transparency masters are included in the teacher edition only and are used to direct the students' attention to the topic of discussion. They may provide illustrations, charts, schematics, or additional information needed to clarify and reinforce objectives included in the unit of instruction.

Use of This Publication

Information sheet (color code: green)

The information sheet provides the content essential for meeting the cognitive (knowledge) objectives of the unit. Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide information for the teaching of each objective.

Student supplements (color code: white)

Student supplements are included in the student edition. The information presented in a student supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the assignment sheets. Students are not directly tested over the information presented in a supplement; however, their ability to apply this information may be evaluated in the completion of assignment sheets.

Assignment sheets (color code: tan)

Assignment sheets provide students with pencil and paper activities that give students the opportunity to make practical application of the knowledge presented in the information sheet.

Written test (color code: yellow)

This component provides criterion-referenced evaluation of every cognitive objective listed in the information sheet. If objectives have been added, deleted, or modified, appropriate changes should be made on the written test. It is recommended that the test be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of test items from the units covered may be used for final tests at the end of each term if desired.

Glossary of technical terms (color code: white)

A glossary of technical terms is provided after the units of instruction. The glossary includes a comprehensive listing of the terms and definitions used within the various units of instruction.

Disseminating material

Material may be given out a unit or page at a time to keep the material before the student always new. Some teachers ask students to furnish a three-ring binder or folder for the current unit of study. This is convenient for students taking the material home to study. Upon completion, each unit is then placed in a larger binder. Some teachers prefer to store the material by unit in filing cabinets or boxes until needed.

For best results, provide student materials for each student. Student editions contain objective sheets, information sheets, student supplements, assignment sheets, and written tests. Students should be allowed to take their materials home at the end of the course.

Architectural Drafting: Commercial Applications

Competency Profile

Name: ______________________________

Directions: Evaluate the student using the rating scale below. Write the appropriate number to indicate the degree of competency achieved. The descriptions associated with each of the numbers focus on a level of student performance for each of the tasks listed. The written-test scoreline is provided for optional teacher use. It may not be applicable in all cases.

Option A

Rating scale:
4 - Skilled - Can perform job with no additional training.
3 - Moderately skilled - Has performed job during training program; limited additional training may be required.
2 - Limited skill - Has performed job during training program; additional training is required to develop skill.
1 - Unskilled - Is familiar with process, but is unable to perform job.
0 - No exposure - No information or practice has been provided during training program; complete training is required.
NA - Non-applicable.

Option B

Yes - Can perform with no additional training
No - Is unable to perform satisfactorily

Unit 1 Introduction to Architectural Drafting

______1. Use an architectural scale

______2. Practice lettering using triangle, extended, and variation styles

______3. Use standard references and resource materials

______4. ______________________________

______Written-test score

Unit 2 Architectural Building Materials

______1. Interpret typical designations for common structural-steel shapes

______2. Practice drawing common building-material symbols

______3. ______________________________

______ Written-test score

Unit 3 Site Conditions

______1. Analyze a potential construction site

______2. Draw a property survey

______3. Draw a plot plan

______4. Determine required cut and fill designations

______5. ______________________________

______Written-test score

Unit 4 Introduction to Working Drawings

______1. Prepare a title block

______2. Determine appropriate drawing scales

______3. Develop a floor plan

______4. Develop elevation drawings

______5. ______________________________

______Written-test score

Unit 5 Section and Detail Drawings

______1. Develop a footing detail

______2. Develop a sill detail

______3. Develop a cornice detail

______4. Select necessary section views from a floor plan

______5. Develop a longitudinal section

______6. Develop a wall-section drawing

______7. ______________________________

______Written-test score

Unit 6 Structural Systems

______1. Analyze the effects of structural forces on building design

______2. Develop a foundation plan

______3. Develop required foundation sections

______4. Develop a roof framing plan

______5. ____

______Written-test score

Unit 7 Architectural Dimensioning

______1. Practice using standard architectural-drafting dimensioning techniques

______2. Dimension a floor plan

______3. Dimension a foundation plan

______4. Dimension an elevation drawing

______5. Dimension a plot plan

______6. Dimension section drawings

______7. ____

______Written-test score

Unit 8 Plumbing Systems

______1. Calculate total fixture units per structure and determine required diameter of building sewer line for a commercial structure

______2. Use the *Uniform Plumbing Code* to answer questions about commercial plumbing systems

______3. Develop a plan drawing of a commercial plumbing system

______4. Develop an isometric drawing of a commercial plumbing system

______5. ____

______Written-test score

Unit 9 HVAC Systems

______1. Use standard HVAC system-design handbooks to answer questions concerning HVAC systems

______2. Develop an HVAC plan

______3. Develop equipment schedules

______4. ____

______Written-test score

Unit 10 Electrical Systems

______1. Use the *National Electrical Code* to answer questions concerning standards for electrical systems

______2. Complete a lighting-fixture schedule

______3. Develop an electrical power-distribution plan

______4. Develop an electrical lighting plan

______5. ____

______Written-test score

Unit 11 Presentation Techniques

______1. Draw a two-point exterior perspective

______2. Render drawings

______3. Construct an architectural model

______4. ____

______Written-test score

Comments: ____

____

____

____

____

Evaluator: __________________________ Date:__________________

* Permission to duplicate this profile is granted.

Architectual Drafting: Commercial Applications

Instructional/Task Analysis

Related information: What the student should know	Application: What the student should be able to do
Unit 1: Introduction to Architectural Drafting	
1. Terms associated with architectural drafting	8. Use an architectural scale
2. Typical levels of architectural job titles and their associated responsibilities and qualifications	9. Practice lettering using triangle, extended, and variation styles
3. Architectural work phases and descriptions of work completed at each phase	10. Use standard references and resource materials
4. Descriptions of architectural-drafting tools and materials	
5. Characteristics of architectural lettering styles	
6. Descriptions of standard references and resource materials used in the design and construction industry	
7. Standard architectural abbreviations	
Unit 2: Architectural Building Materials	
1. Terms associated with architectural building materials	
2. Common types of architectural building materials	
3. Characteristics of lumber used in construction	
4. Types of wood products commonly used in construction and their definitions	
5. Types of steel products commonly used in construction and their descriptions	

Related information: What the student should know	Application: What the student should be able to do
Unit 2 (cont.)	
6. Definitions of the terms *cement* and *concrete*	14. Interpret typical designations for common structural-steel shapes
7. Types of masonry products commonly used in construction and their definitions	15. Practice drawing common building-material symbols
8. Types of fasteners commonly used in construction and their descriptions	
9. Types of glazing products commonly used in construction and their descriptions	
10. Types of thermal-insulation materials commonly used in construction and their descriptions	
11. Thermal-insulation applications and their descriptions	
12. Types of damp-proofing and drainage materials commonly used in construction and their descriptions	
13. Common construction-material symbols	
Unit 3: Site Conditions	
1. Terms associated with site conditions	
2. General questions considered in conducting a site analysis	
3. Descriptions of climate-orientation factors considered in conducting a site analysis	
4. Physical characteristics of a site considered in conducting a site analysis and their definitions	

Related information: What the student should know	Application: What the student should be able to do
Unit 3 (cont.)	
5. Site-clearing and removal practices considered when conducting a site analysis and their definitions	11. Analyze a potential construction site 12. Draw a property survey
6. Definitions of types of drawings commonly completed as part of a site analysis	13. Draw a plot plan 14. Determine required cut and fill designations
7. Components of a property survey	
8. Components of a plot plan	
9. Symbols commonly used on a plot plan	
10. Components of a grading plan and their definitions	
Unit 4: Introduction to Working Drawings	
1. Terms associated with working drawings	
2. Descriptions of types of drawings usually included in a set of working drawings	
3. Types of drawings in a set of working drawings and descriptions of the information found in each type	
4. Standard sequence of drawings in a set of working drawings	
5. Description of the drawing-identification system used in a set of working drawings	
6. Components of a title block	
7. Standard architectural-linework techniques	
8. Plan symbols used on floor plans	

	Related information: What the student should know		Application: What the student should be able to do
	Unit 4 (cont.)		
9.	Plan symbols used on elevation drawings	12.	Prepare a title block
10.	Symbols and methods used in cross-referencing drawings	13.	Determine appropriate drawing scales
11.	Standard headings presented in drawing schedules	14.	Develop a floor plan
		15.	Develop elevation drawings
	Unit 5: Section and Detail Drawings		
1.	Terms associated with section and detail drawings	10.	Develop a footing detail
2.	Architectural methods used in drawing cutting-plane lines	11.	Develop a sill detail
3.	Definitions of the terms *detail drawing* and *section drawing*	12.	Develop a cornice detail
4.	Types of architectural section drawings and their descriptions	13.	Select necessary section views from a floor plan
5.	Symbols used on section drawings	14.	Develop a longitudinal section
6.	Types of architectural detail drawings and their descriptions	15.	Develop a wall-section drawing
7.	Stairway features described on stairway details		
8.	Reference methods used for sections and details		
9.	Symbols used in referencing sections and details		

Related Information: What the student should know	Application: What the student should be able to do
Unit 6: Structural Systems	
1. Terms associated with structural systems	16. Analyze the effects of structural forces on building design
2. Definition of the term *structural system*	17. Develop a foundation plan
3. Types of materials used in structural systems	18. Develop required foundation sections
4. Descriptions of the types of forces exerted on a structural system	19. Develop a roof framing plan
5. Definitions of the major components of a structural system	
6. Purposes of the basic components of a substructure	
7. Types of footings	
8. Types of information shown on a foundation plan	
9. Basic types of superstructures and their descriptions	
10. Factors considered in commercial roof design	
11. Types of roofs	
12. Types of materials used as roof framing members	
13. Types of materials used as roof coverings and their descriptions	
14. Descriptions of other components to be considered in commercial roof design	
15. Types of information shown on a roof framing plan	

Related information: What the student should know	Application: What the student should be able to do
Unit 7: Architectural Dimensioning	
1. Terms associated with dimensioning	5. Practice using standard architectural-drafting dimensioning techniques
2. Statements concerning standard architectural-drafting dimensioning techniques	6. Dimension a floor plan
3. Statements concerning metric-system dimensioning techniques	7. Dimension a foundation plan
	8. Dimension an elevation drawing
4. Statements concerning modular-drafting drawing and dimensioning techniques	9. Dimension a plot plan
	10. Dimension section drawings
Unit 8: Plumbing Systems	
1. Terms associated with plumbing systems	
2. Major types of plumbing systems and their descriptions	
3. Descriptions of the major subsystems of a plumbing system	
4. Components of a water-distribution system and their definitions	
5. Characteristics of a well-designed water-distribution system for a commercial structure	
6. Major parts of a waste-disposal system and their descriptions	
7. Characteristics of a well-designed waste-disposal system for a commercial structure	
8. Piping symbols and abbreviations	
9. Plan- and elevation-view plumbing-fixture symbols	
10. Definitions of types of plans drawn for commercial plumbing systems	

Related information: What the student should know	Application: What the student should be able to do
Unit 8 (cont.)	
11. Descriptions of drawing methods used in completing plumbing and piping plans	14. Calculate total fixture units per structure and determine required diameter of building sewer line for a commercial structure
12. Descriptions of the types of drawings done for piping and plumbing plans	15. Use the *Uniform Plumbing Code* to answer questions about commercial plumbing systems
13. Factors to consider when deciding which type of drawing to use to illustrate piping and plumbing plans	16. Develop a plan drawing of a commercial plumbing system
	17. Develop an isometric drawing of a commercial plumbing system
Unit 9: HVAC Systems	
1. Terms associated with HVAC systems	
2. Definitions of abbreviations commonly used in HVAC design	
3. Definition of the term, *air-conditioning*	
4. Major subsystems of an HVAC system	
5. Major types of commercial heating systems and their descriptions	
6. Definitions of classifications of cooling systems	
7. Descriptions of the major types of central cooling systems	
8. Basic components of a ventilation system	
9. Types of ventilation systems	
10. Climatic zones in the 48 adjacent states of the United States and their correct descriptions	

Related information: What the student should know	Application: What the student should be able to do
Unit 9 (cont.)	
11. Factors used in determining HVAC-system size requirements	15. Use standard HVAC system-design handbooks to answer questions concerning HVAC systems
12. Standard HVAC system-design handbooks and specification manuals and descriptions of the type of information contained in each book	16. Develop an HVAC plan 17. Develop equipment schedules
13. HVAC-system drafting symbols	
14. Purposes of types of HVAC equipment schedules	
Unit 10: Electrical Systems	
1. Terms associated with electrical systems	
2. Units of measure associated with electrical systems and their correct definitions	
3. Major subsystems of a commercial structure's electrical system	
4. Equipment and materials used in power-distribution systems and their definitions	
5. Materials used in installing electrical power-distribution systems and their definitions	
6. Descriptions of the major types of lighting sources	
7. Common types of equipment requiring an electrical service load within commercial structures	
8. Symbols used on electrical plans	
9. Purposes of types of drawings commonly completed for a structure's electrical system	

Related information: What the student should know	Application: What the student should be able to do
Unit 10 (cont.)	
10. Components of an electrical power-distribution plan	13. Use the *National Electrical Code* to answer questions concerning standards for electrical systems
11. Components of an electrical lighting plan	14. Complete a lighting-fixture schedule
12. Purposes of types of electrical schedules	15. Develop an electrical power-distribution plan
	16. Develop an electrical lighting plan
Unit 11: Presentation Techniques	
1. Terms associated with presentation techniques	7. Draw a two-point exterior perspective
2. Definition of the term *presentation drawing*	8. Render drawings
3. Types of presentation drawings and their definitions	9. Construct an architectural model
4. Components of a perspective drawing and their descriptions	
5. Common uses for types of rendering media	
6. Uses for materials commonly used to construct architectural models	

Academic and Workplace Skills
Classifications and Definitions

Skill groups	Subskills	Definitions
Learning skills	Learning to learn	Developing ability to apply knowledge to other situations; knowing how to learn.
Foundation skills	Reading	Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task.
	Writing	Communicating a thought, idea, or fact in written form in a clear, concise manner.
	Math	Applying computation skills such as reasoning, estimation, and problem solving as they are actually used on the job.
	Science	Applying knowledge learned through study or practice that is based on scientific principles as they relate to specific tasks.
Communication skills	Listening	Listening for content, conversation, long-term contexts, emotional meaning, and directions.
	Oral communication	Communicating a thought, idea, or fact in spoken form in a clear, concise manner.
Adaptability skills	Creative thinking	Using imagination to create something new—i.e. an idea, invention, work of art.
	Problem solving (critical thinking)	Recognizing and defining problems, inventing, and implementing solutions, and tracking and evaluating results.
Personal-management skills	Self-esteem	Developing self-confidence and creating a positive self-image.
	Motivation/goal setting	Setting and meeting defined goals and objectives.
	Personal and career development	Emphasizing self-direction by establishing and implementing a plan.
Group-effectiveness skills	Interpersonal relations	Developing the ability to maintain positive relations with others.
	Negotiation	Resolving conflict between two or more individuals.
	Teamwork	Working together in a group to reach a common goal.
Influence skills	Organizational effectiveness	Adapting to the organization's goals, values, culture, and traditional modes of operation.
	Leadership	Directing/influencing a group in performance of a specific task; accepting responsibility for others.

Related Academic and Workplace Skills List
For *Architectural Drafting: Commercial Applications*

Task	*Skill group*	*Subskill*	*Description*
Unit 1: Introduction to Architectural Drafting			
Use an architectural scale (A.S. 1)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements using an architectural scale
Practice lettering using triangle, extended, and variation styles (A.S. 2)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
Use standard references and resource materials (A.S. 3)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
			• Uses standard occupational resource materials
		Writing	• Communicates a fact in written form in a clear, concise manner
Unit 2: Architectural Building Materials			
Interpret typical designations for common structural-steel shapes (A.S. 1)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Writing	• Communicates a fact in written form in a clear, concise manner
Practice drawing common building-material symbols (A.S. 2)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results

Task	Skill group	Subskill	Description
Unit 3: Site Conditions			
Analyze a potential construction site (A.S. 1)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes rough measurements • Constructs geometric figures
		Writing	• Communicates thoughts in written form in a clear, concise manner
	Adaptability skills	Problem solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
Draw a property survey (A.S. 2)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements • Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
Draw a plot plan (A.S. 3)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements • Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
Determine required cut and fill designations (A.S. 4)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Applies computation skills as they are actually used on the job
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results

Task	Skill group	Subskill	Description
	Unit 4: Introduction to Working Drawings		
Prepare a title block (A.S. 1)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Determine appropriate drawing scales (A.S. 2)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Calculates/estimates surface area
			• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
Develop a floor plan (A.S. 3)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Calculates/estimates surface area
			• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Develop elevation drawings (A.S. 4)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements
			• Constructs geometric figures

Task	Skill group	Subskill	Description
Unit 4 (cont.)			
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Unit 5: Section and Detail Drawings			
Develop a footing detail (A.S. 1)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements • Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
Develop a sill detail (A.S. 2)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements • Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
Develop a cornice detail (A.S. 3)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task • Uses standard occupational resource materials
		Math	• Makes precision measurements • Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates result
Select necessary section views from a floor plan (A.S. 4)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task

Task	Skill group	Subskill	Description
		Unit 5 (cont.)	
		Math	• Makes precision measurements
			• Constructs geometric figures
		Writing	• Communicates facts in written form in a clear, concise manner
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Develop a longitudinal section (A.S. 5)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
			• Uses standard occupational resource materials
		Math	• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Develop a wall-section drawing (A.S. 6)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
		Unit 6: Structural Systems	
Analyze the effects of structural forces on building design (A.S. 1)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task

Task	Skill group	Subskill	Description
Unit 6 (cont.)			
		Writing	• Communicates a fact in written form in a clear, concise manner
Develop a foundation plan (A.S. 2)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Develop required foundation sections (A.S. 3)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements
			• Constructs geometric figures
		Writing	• Communicates facts in written form in a clear, concise manner
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Develop a roof framing plan (A.S. 4)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new

Task	Skill group	Subskill	Description
Unit 7: Architectural Dimensioning			
Practice using standard architectural-drafting dimensioning techniques (A.S. 1)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
Dimension a floor plan (A.S. 2)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
Dimension a foundation plan (A.S. 3)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
Dimension an elevation drawing (A.S. 4)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
Dimension a plot plan (A.S. 5)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
Dimension section drawings (A.S. 6)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task

Task	Skill group	Subskill	Description
		Unit 7 (cont.)	
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Unit 8: Plumbing Systems	
Calculate total fixture units per structure and determine required diameter of building sewer line for a commercial structure (A.S. 1)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Interprets charts/tables/graphs • Computes using a formula
Use the *Uniform Plumbing Code* to answer questions about commercial plumbing systems (A.S. 2)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task • Uses standard occupational resource materials
		Writing	• Communicates a fact in written form in a clear, concise manner
Develop a plan drawing of a commercial plumbing system (A.S. 3)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements • Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Develop an isometric drawing of a commercial plumbing system (A.S. 4)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements • Constructs geometric figures

Task	Skill group	Subskill	Description
Unit 8 (cont.)			
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Unit 9: HVAC Systems			
Use standard HVAC system-design handbooks to answer questions concerning HVAC systems (A.S. 1)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
			• Uses standard occupational resource materials
		Writing	• Communicates a fact in written form in a clear, concise manner
Develop an HVAC plan (A.S. 2)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Develop equipment schedules (A.S. 3)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
			• Uses standard occupational resource materials
		Writing	• Communicates a fact in written form in a clear, concise manner
Unit 10: Electrical Systems			
Use the *National Electrical Code* to answer questions concerning standards for electrical systems (A.S. 1)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
			• Uses standard occupational resource materials

Task	Skill group	Subskill	Description
Unit 10 (cont.)			
		Writing	• Communicates a fact in written form in a clear, concise manner
Complete a lighting-fixture schedule (A.S. 2)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
			• Uses standard occupational resource materials
			• Communicates facts in written form in a clear, concise manner
Develop an electrical power-distribution plan (A.S. 3)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Develop an electrical lighting plan (A.S. 4)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Math	• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Unit 11: Presentation Techniques			
Draw a two-point exterior perspective (A.S. 1)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task

Task	Skill group	Subskill	Description
Unit 11 (cont.)			
		Math	• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Render drawings (A.S. 2)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Writing	• Communicates facts in written form in a clear, concise manner
		Math	• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new
Construct an architectural model (A.S. 3)	Foundation skills	Reading	• Comprehends written information; analyzes and applies what has been read to a specific task
		Writing	• Communicates facts in written form in a clear, concise manner
		Math	• Makes precision measurements
			• Constructs geometric figures
	Adaptability skills	Problem-solving (critical thinking)	• Recognizes and defines problem; invents and implements solution; tracks and evaluates results
		Creative thinking	• Uses imagination to create something new

Architectural Drafting: Commercial Applications

Reference List

Allen, Edward. *Fundamentals of Building Construction—Materials and Methods.* New York: John Wiley and Sons, 1985.

ASHRAE Handbook. Atlanta, Georgia: American Society of Heating, Refrigeration, and Air-Conditioning Engineers, 1982.

Biachina, Paul. *Illustrated Dictionary of Building Materials and Techniques.* Blue Ridge Summit, Pennsylvania: Tab Books, Inc., 1986.

Callendar, John H. *Time-Saver Standards for Architectural Design Data.* New York: McGraw-Hill, 1982.

Harris, Cyril M. *Dictionary of Architecture and Construction.* New York: McGraw-Hill, 1983.

Helper, D. E., and Paul Wallach. *Architecture: Drafting and Design.* New York: McGraw-Hill, 1987.

Hettema, Robert M. *Mechanical and Electrical Building Construction.* Englewood Cliffs, New Jersey: Prentice-Hall, 1984.

Lewis, Jack R. *Architectural Draftsmans Reference Handbook.* Englewood Cliffs, New Jersey: Prentice-Hall, 1982.

Lynch, Kevin. *Site Planning.* Cambridge, Massachusetts: MIT Press, 1984.

Muller, Edward J. *Architectural Drawing and Light Construction.* Englewood Cliffs, New Jersey: Prentice-Hall, 1985.

National Electrical Code. Quincy, Massachusetts: National Fire Protection Association, 1987.

Putnam, Robert. *Building Trades Blueprint Reading.* Reston, Virginia: Reston Publishing (Prentice-Hall Co.), 1986.

Ramsey, Charles. *Architectural Graphic Standards,* 8th ed. New York: Wiley and Sons, 1988.

Spence, William P. *Architecture: Design—Engineering—Drawing.* Bloomington, Illinois: Glencoe, Bennett, and McKnight, 1985.

Toenjes, Leonard P. *Building Trades Dictionary.* Homewood, Illinois: American Technical Publishers, 1989.

Traister, John E. *Practical Drafting for the HVAC Trades.* Indianapolis, Indiana: Howard W. Sams and Company, 1981.

Uniform Mechanical Code. Walnut, California: International Association of Plumbing and Mechanical Officials, 1988.

Uniform Plumbing Code, 1988 ed. Walnut, California: International Association of Plumbing and Mechanical Officials, 1988.

Weidhaas, Ernest R. *Reading Architectural Plans.* Boston: Allyn and Bacon, 1977.

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

UNIT OBJECTIVE

After completing this unit, the student should be able to identify responsibilities and qualifications associated with typical architectural job titles and descriptions of architectural work phases. The student should also be able to use an architectural scale, letter using three common architectural styles, and use standard industry reference materials. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with architectural drafting to their correct definitions.
2. Match typical levels of architectural job titles to their associated responsibilities and qualifications.
3. Identify architectural work phases according to descriptions of work completed at each phase.
4. State descriptions of architectural-drafting tools and materials.
5. State characteristics of architectural lettering styles.
6. State descriptions of standard references and resource materials used in the design and construction industry.
7. Interpret standard architectural abbreviations.
8. Use an architectural scale. (Assignment Sheet 1)
9. Practice lettering using triangle, extended, and variation styles. (Assignment Sheet 2)
10. Use standard references and resource materials. (Assignment Sheet 3)

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

SUGGESTED ACTIVITIES

Preparation

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery and Application" section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.
- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section.
- Make transparencies from the transparency masters included in this unit.
- Duplicate teacher supplements included in this unit, as required.
- Prepare classroom and lab. Put up posters, charts, and signs; display articles and other references related to the objectives of this unit.

Delivery and Application

Unit introduction

- Provide students with objective sheet. Discuss unit and specific objectives.
- Show the film *Beyond Utopia: Changing Attitudes in American Architecture* or *The New Architecture.*
- Recommend that students read *Architectural Practice, A Critical Review.*
- Take a field trip to an architectural planning firm. Have students note the types of drawings done at the firm and the lettering techniques and tools and materials the drafters use in completing the drawings. Also have students note the reference and resource materials the firm's staff makes use of.

BEST COPY AVAILABLE

SUGGESTED ACTIVITIES

- Provide students with information and assignment sheets. Discuss information and assignment sheets.

Objective 1 Match terms associated with architectural drafting to their correct definitions.

- Show examples that illustrate terms and make examples available in the classroom.

Objective 2 Match typical levels of architectural job titles to their associated responsibilities and qualifications.

- Invite an architect who is responsible for hiring to speak to the class on the qualifications he or she looks for when hiring an entry-level drafter.
- Make available to students *Architectural Drafting (Occupational Competency Examination)*. Discuss with students the competencies required by an architectural drafter in the profession today.
- Have students write for career information in architecture to

  Director, Education Programs
  The American Institute of Architects
  1735 New York Avenue, N.W.
  Washington, D.C. 20006

- Make available to students a copy (or copies) of *Opportunities in Architecture*, and discuss the contents of the book with the students. In addition, encourage students to visit career counselors and explore libraries in order to research further information about the architectural profession.
- Hand out copies of Teacher Supplement 1, "Interview an Architectural Drafter." Have students make an appointment to interview an architectural drafter who is presently employed in that capacity. Students should use the questions on the supplement as guidelines for their interview. After the students have completed the interviews, hold a class discussion concerning the results.

Objective 3 Identify architectural work phases according to descriptions of work completed at each phase.

- List on the board the five architectural work phases; discuss the descriptions of the work completed at each stage. Hand out copies of Teacher Supplement 2, "Flow Chart Showing Work Phases and Responsible Parties," and then tie the information in Objective 2 to the information in this objective by discussing the parties responsible for the completion of work at each architectural phase.

SUGGESTED ACTIVITIES

Objective 4 State descriptions of architectural-drafting tools and materials.

- Show students samples of each of the various types of tools and materials discussed in the information sheet. Have students recall how they saw these tools being used on the field trip they took to the architectural planning firm and list these uses on the board. Compare the listings made during the class discussion with the descriptions given in the information sheet.

- Demonstrate to students the use of each tool presented.

- Discuss Assignment Sheet 1, "Use an Architectural Scale." Read the introduction to the assignment sheet and then hand out Student Supplement 1, "Guidelines for Using an Architectural Scale." Demonstrate the steps presented in the supplement. Have students complete Assignment Sheet 1.

Objective 5 State characteristics of architectural lettering styles.

- Use Transparencies 1 through 4 to discuss the characteristics of the various types of lettering styles used on architectural drawings. Attach a clear acetate overlay to each transparency and demonstrate how the strokes for each type of lettering style are made as you discuss the written characteristics presented in the information sheet.

- Show students samples of each type of lettering style on actual drawings. Discuss with students that the triangle, extended, and variation styles are the styles most commonly used on drawings and that kabel modern, chisel, condensed, and shadow are rarely used except in special cases. Point out on the drawings where and why each style has been used.

- Review with students the information presented Student Supplement 2, "Lettering Guidelines" and in the introduction to Assignment Sheet 2, "Practice Lettering Using Triangle, Extended, and Variation Styles." Emphasize to students the importance of their being able to letter well.

- Have students complete the tracing exercise presented in Part A of the assignment and then critique their work or have them critique each others lettering strokes. When all have successfully completed the tracing exercise, have students complete the actual lettering exercises presented in Part B, C, and D of the assignment.

SUGGESTED ACTIVITIES

Objective 6 State descriptions of standard references and resource materials used in the design and construction industry.

- Have samples of each of the standard references available in the classroom for student use. Discuss the descriptions of these standard books, relating to students why and when these books are used in the development of architectural drawings and documents.
- Make students aware that there is a growing trend to make these standard references available through a computer-access network. The Sweets catalog reference system is currently available in this form.
- Read with students Student Supplement 3, "Guidelines for Using Standard Architectural References and Resource Materials" and the introduction presented in Assignment Sheet 3, "Use Standard References and Resource Materials." Demonstrate to students how to look up information in each of these books. Then have students break into groups and work together to locate specific answers to questions you supply.
- Have students complete the exercises in Assignment Sheet 3.
- Discuss other common reference materials often used in the profession, such as the *Architectural Draftsman's Reference Handbook* and the *National Fire Protection Code (NFPC) Handbook*. Make copies of these texts available to students also.

Evaluation

- Give written test.
- Compile written-test and assignment-sheet scores on Unit Evaluation Form.
- Reteach and retest as required.

Suggested Resources

Resources used in developing unit

Print media

- Callendar, John H. *Time-Saver Standards for Architectural Design Data*. New York: McGraw-Hill, 1982.
- Helper, D. E., and Paul Wallach. *Architecture: Drafting and Design*. New York: McGraw-Hill, 1987.

SUGGESTED ACTIVITIES

- Muller, Edward J. *Architectural Drawing and Light Construction.* Englewood Cliffs, New Jersey: Prentice-Hall, 1985.
- Ramsey, Charles. *Architectural Graphic Standards*, 8th ed. New York: Wiley and Sons, 1988.
- Spence, William P. *Architecture: Design—Engineering—Drawing.* Bloomington, Illinois: Glencoe, Bennett, and McKnight, 1985.
- Weidhaas, Ernest R. *Reading Architectural Plans.* Boston: Allyn and Bacon, 1977.

Resources to be used as student references

NOTE: The materials listed below were used as resources in preparing certain components. Copies of these materials may be required by students in completing assignments.

- Croft, Terrell, and Wieford Summers. *American Electricians Handbook.* New York: McGraw-Hill, 1987.
- McGraw-Hill Information Systems Company. *Sweets Catalog File Master Index*. New York: McGraw-Hill, 1988.
- Ramsey, Charles G. *Architectural Graphic Standards*, 8th ed. New York: Wiley and Sons, 1988.
- *Uniform Building Code*, 1988 ed. Whittier, California: International Conference of Building Officials, 1988.
- *Uniform Mechanical Code*, 1988 ed. Walnut, California: International Association of Plumbing and Mechanical Officials, 1988.
- *Uniform Plumbing Code*, 1988 ed. Walnut, California: International Association of Plumbing and Mechanical Officials, 1988.

Additional resources

Media

- *Beyond Utopia: Changing Attitudes in American Architecture.* Copyright 1984, available on VHS and ¾-inch tape, 58 minutes. Blackwood Productions, 251 W. 57th Street, New York, New York.

  This program presents the world and theories of five prominent American architects and their impact on today's society and its values.

SUGGESTED ACTIVITIES

- *The New Architecture.* Copyright 1985, available on VHS and ¾-inch tape, 60 minutes. Blackwood Productions, 251 W. 57th Street, New York, New York.

  This program presents six distinct segments outlining the triumphs and disappointments of prominent modern architects in today's world.

Print media

- Gutman, Robert. *Architectural Practice, A Critical Review.* 133 pages, Princeton, New Jersey: Princeton Architectural Press, 1988.

  This book, written as a critical essay, addresses accepted practices in the architectural industry and presents their inherent flaws. The author emphasizes the changes needed to restore the industry's traditional and vital role in America.

- Lewis, Jack R. *Architectural Draftsmans Reference Handbook.* 116 pages, Englewood Cliffs, New Jersey: Prentice-Hall, 1982.

  This valuable reference text contains standard tables and charts showing sizes, strengths, weights, etc., for commonly used architectural building materials. The book also shows common symbol representation for architectural drawings.

- Piper, Robert J. *Opportunities in Architecture.* 107 pages, Chicago, Illinois: National Textbook Co., 1985.

  This excellent book is written for anyone interested in pursuing a career in the field of architecture. It discusses career opportunities and their positive and negative aspects, educational requirements, and recommended preparatory subjects for entrance into the profession.

- Rudman, Jack. *Architectural Drafting (Occupational Competency Examination).* National Learning, 1988.

  This competency exam was developed to represent the specific level of competency required by an architectural drafter in the profession today. Areas covered by the exam include drafting practices, construction specifications, construction materials and methods, and mathematics.

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

Evaluated to the satisfaction of the instructor.

EVALUATOR'S NOTE: Lines should be drawn to the exact dimensions indicated in the assignment-sheet exercise.

Assignment Sheet 2

Evaluated to the satisfaction of the instructor.

EVALUATOR'S NOTE: Letters should meet guidelines presented in Student Supplement 2 and in Objective 5 of the information sheet.

Assignment Sheet 3

Part A

1. 11 inches (pg. 174)
2. 24 hours (pg. 108)
3. 1-2, as defined by local code (pg. 71)

Part B

1. 03100 (pg. 7)
2. Athletic rooms (pg. 31)
3. 09300/GEO (pg. 44)

Part C

1. Section 1207 (a)
2. Factory-built, masonry, metal (pg. 75)
3. 12 inches (pg. 67)

Part D

1. Section 210-8

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

ANSWERS TO WRITTEN TEST

1. a. 1
   b. 8
   c. 5
   d. 6
   e. 2
   f. 7
   g. 4
   h. 3
   i. 9

2. a. 1
   b. 4
   c. 2
   d. 5
   e. 3

3. a. 3
   b. 5
   c. 1
   d. 4
   e. 2

4. a. Provides common fractional-inch scales where fractional-inch increments represent a unit of measure equal to 1 foot in length

   b. Provides to-scale templates for drawing landscaping symbols such as trees, shrubs, fences, posts, and hedges

   c. Provides to-scale templates for drawing door-swing, bathroom-fixture, kitchen-appliance, and cabinetry symbols

   d. Provides to-scale templates for drawing standard plumbing symbols such as shower stalls, urinals, toilets, and water fountains

   e. Provides common scales where 1-inch increments represent a unit of measure equal to a given number of feet

5. a. Freehand letters drawn so that top portions of letters extend downward and widths of letters are widened, making letters appear top-heavy and almost as wide as they are high

   b. Freehand letters drawn with high horizontal strokes on letters E, F, and H; with rounded ends on letters K, Q, R, and S; and with extended widths on all letters so that letters appear wider than normal

   c. Freehand letters drawn with high horizontal strokes on letters E, F, and H; with rounded ends on letters K, Q, R, and S; with large ovals on circular letters; and with condensed widths on all other letters so that letters appear very narrow

ANSWERS TO WRITTEN TEST

d. Structured freehand letters drawn with emphasis strokes created with a widened pencil width

e. Letters with vertical strokes drawn with a straightedge and extended higher than top of letters with rounded strokes; letters with rounded strokes drawn freehand and in an oval shape

f. Structured freehand letters drawn approximately three times as high as they are wide so that letters appear very narrow

g. Letters drawn with the aid of a stencil and created by omitting selected lines from stencil pattern

6. a. Industry-recognized handbook used as a resource for standards and criteria concerning electrical applications in the construction industry

b. Industry-recognized handbook used as a resource for standard dimensions, construction methods, materials, and structural data

c. Manual established by the International Conference of Building Officials and used as a resource for standards and installation guidelines pertaining to mechanical systems

d. Industry-recognized catalog file used as a resource for manufacturers' product information

e. Manual of design and construction criteria established by the International Conference of Building Officials and used by regional building departments as a guide for the approval of architectural plans and specifications

f. Manual established by the International Association of Plumbing and Mechanical Officials and used as a resource for standards and installation guidelines pertaining to plumbing systems

7. a. architectural
b. Association
c. American National Standards Institute
d. Company
e. contractor
f. construction
g. engineer
h. specification
i. schematic
j. American Institute of Architects

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

UNIT EVALUATION FORM

Student name ______________________________ Unit rating __________

Assignment sheet ratings

Assignment Sheet 1—Use an Architectural Scale Rating __________

Comments: ____

____

Assignment Sheet 2—Practice Lettering Using Triangle, Extended, and Variation Styles Rating __________

Comments: ____

____

Assignment Sheet 3—Use Standard References and Resource Materials Rating __________

Comments: ____

____

Written test scores

Pretest __________ Other __________

Posttest __________

Instructor signature ______________________________ Date __________

Student signature ______________________________ Date __________

Duplication of this form is permitted

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

TEACHER SUPPLEMENT 1—INTERVIEW AN ARCHITECTURAL DRAFTER

Directions Make an appointment with an architectural drafter who is presently employed in that capacity. Use the following questions as guidelines for your interview. By asking the following questions, you will be able to better determine whether the field of architecture is the vocation you want to pursue and what particular skills you will need in order to be successful as an architectural drafter.

1. What is your career title?

   ____

2. What tasks do you perform on the job?

   ____

   ____

   ____

3. What educational qualifications and occupational experiences are required for this job?

   ____

   ____

   ____

4. What personality traits are most important in your field?

   ____

   ____

   ____

5. What skills and knowledge are required in this occupation?

   ____

   ____

   ____

Duplication of this teacher supplement is permitted.

TEACHER SUPPLEMENT 1

6. What is the approximate starting salary of workers in your occupation?

7. What is the employment outlook for the future in this career?

8. What are the possibilities for advancement in this field?

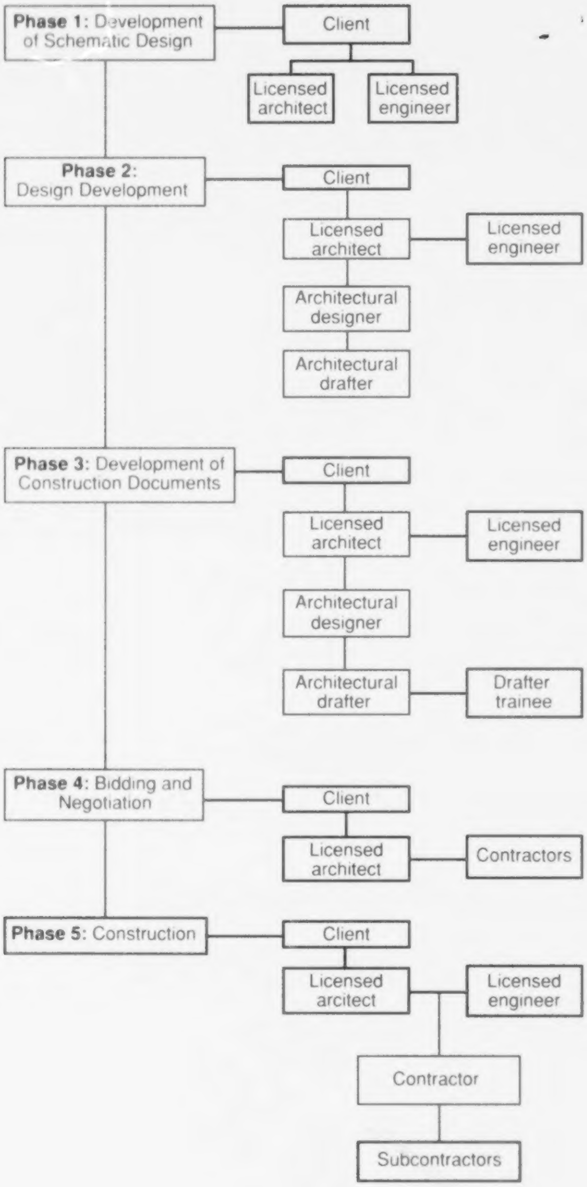
9. What is your favorite part of this job?

10. What is your least favorite part of this job?

11. What is the dress code in your firm?

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

TEACHER SUPPLEMENT 2—FLOW CHART SHOWING ARCHITECTURAL WORK PHASES AND RESPONSIBLE PARTIES


Phase 1: Development of Schematic Design
Client
Licensed architect
Licensed engineer
Phase 2: Design Development
Client
Licensed architect
Licensed engineer
Architectural designer
Architectural drafter
Phase 3: Development of Construction Documents
Client
Licensed architect
Licensed engineer
Architectural designer
Architectural drafter
Drafter trainee
Phase 4: Bidding and Negotiation
Client
Licensed architect
Contractors
Phase 5: Construction
Client
Licensed arcitect
Licensed engineer
Contractor
Subcontractors

Duplication of this teacher supplement is permitted.

Architectural Lettering Styles

Triangle

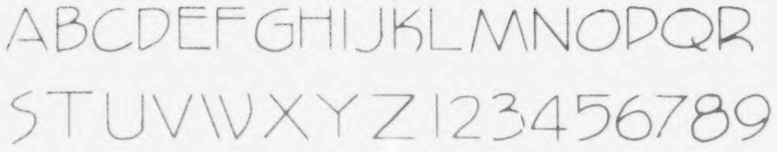
ABCDEFGHIJKLMNOPQR
STUVWXYZ 1234567890

Extended

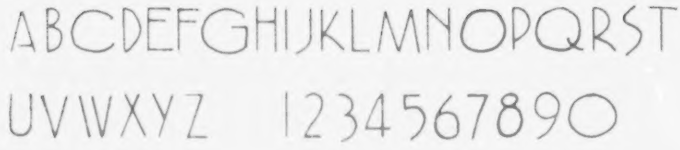
ABCDEFGHIJKLMNO
PQRSTUVWXYZ
1234567890

Architectural Lettering Styles
(Continued)

Variation


ABCDEFGHIJKLMNOPQR
STUVWXYZ 123456789

Kabel modern


ABCDEFGHIJKLMNOPQRST
UVWXYZ 1234567890

Architectural Lettering Styles
(Continued)

Chisel

ABCDEFGHIJKLMNOPQ
RSTUVWXYZ 123456789

Condensed

ABCDEFGHIJKLMNOPQRS
TUVWXYZ 1234567890

Architectural Lettering Styles
(Continued)

Shadow

A B C D E F G H I J K L M
N O P Q R S T U V W X
Y Z 1 2 3 4 5 6 7 8 9

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

INFORMATION SHEET

1. **Terms and definitions associated with architectural drafting**

    a. **Architecture**—The art and science of planning and designing buildings

    b. **Bidding phase**—Architectural work phase during which bids and negotiated proposals are sought as the basis for awarding construction contract

    c. **Contractor**—Person or firm that undertakes responsibility for the performance of construction work

    NOTE: A contractor may be either a general contractor or a subcontractor. A general contractor is responsible for the overall project while a subcontractor is responsible for a specific portion of the project (i.e., electrical, structural, mechanical).

    d. **Construction documents**—Composite of all working drawings and written specifications associated with a specific construction project

    e. **Floor plan**—Drawing indicating building size and interior-room arrangement

    f. **Schematic design**—Initial architectural work phase during which project requirements are determined and preliminary drawings are created

    g. **Specifications**—Set of precisely written documents that describe the contract parameters and quality of work to be performed during construction of a project

    h. **Site diagram**—Drawing that defines the boundaries of the land on which a building is to be located

    i. **Working drawings**—Set of drawings used to construct a proposed building or structure

2. **Typical levels of architectural job titles and their associated responsibilities and qualifications**

    NOTE: The job titles listed below and their associated responsibilities and qualifications are common throughout the industry. However, with the exception of *licensed architect* and *licensed engineer*, responsibilities and qualifications for job titles may vary from firm to firm and from state to state.

    a. **Architectural drafter trainee**

        (1) Responsibilities

        - Runs prints and maintains drawing files

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INFORMATION SHEET

- Inks all lines and lettering on drawings as required
- Works under supervision of chief drafter or architect

(2) Qualifications

- Has obtained high-school diploma or is successfully working toward one
- Has successfully completed coursework in a vocational architectural-drafting program
- Has successfully completed one year of algebra and one year of geometry
- Has maintained a good school-attendance record
- Can supply good character references

b. **Architectural drafter**

(1) Responsibilities

NOTE: Responsibilities of an architectural drafter vary with the drafter's experience and ability, but basic responsibilities include the following.

- Prepares pictorial and working drawings
- Makes reproducible drawings from architect's or designer's sketches
- Prepares drawing schedules from written specifications

(2) Qualifications

- Has obtained high-school diploma
- Has successfully completed two or more years in a vocational architectural-drafting program
- Has successfully completed one year of algebra and one year of geometry
- Can supply good character references

c. **Architectural designer**

(1) Responsibilities

- Sketches plans for drafters

INFORMATION SHEET

- Develops design layouts
- Produces complex detail drawings

(2) Qualifications

- Has successfully completed an associate degree in a technical area
- Has completed a minimum of five years of drafting experience
- Can supply good work credentials

d. **Licensed architectural engineer**

(1) Responsibilities

- Uses handbooks and reference materials to determine design specifications and correct data concerning building materials to be used
- Makes mathematical computations involving strength of structural materials

(2) Qualifications

NOTE: Qualifications for licensed architectural engineers may vary from state to state; however, the following are the minimum qualifications required in most states.

- Has successfully completed approved six-year bachelor's degree program in engineering
- Has successfully completed engineer-in-training (EIT) examination
- Has successfully completed apprenticeship program under the supervision of a licensed engineer
- Has successfully completed practicing-engineer (PE) examination for engineering specialty area

e. **Licensed architect**

(1) Responsibilities

- Develops design concepts, proposals, and presentations for the purpose of acquiring projects for firm
- Determines design specifications (i.e., sizes, materials, colors)
- Makes job-site observations

INFORMATION SHEET

- Supervises subordinates
- Manages business aspects of project

(2) Qualifications

NOTE: Qualifications for licensed architects are set forth by the American Institute of Architects and by individual state registration boards; however, the following are the minimum qualifications required in most states.

- Has successfully completed bachelor's degree in architecture from a National Architectural Accrediting Board-approved program
- Has successfully completed three-year apprenticeship program under supervision of licensed architect
- Has successfully completed both theory and design-problem divisions of the state-board examination for architects

3. **Architectural work phases and descriptions of work completed at each phase**

a. **Phase 1: Development of schematic design**

- Rough site diagram and floor plans are developed
- Implications of local zoning codes and regulations are examined
- Estimate of overall construction costs is completed
- Statements of architect's design concept and engineering requirements are completed
- Color presentation drawings and elaborate visual aids are completed to help gain client approval

b. **Phase 2: Design development**

- Schematic design is refined
- Precise line drawings and written specifications are completed
- Cost analysis is refined

c. **Phase 3: Development of construction documents**

- Written description of type, quantity, and quality of materials to be used in building construction is completed
- Survey is conducted and accurate drawing of proposed building site is completed

INFORMATION SHEET

- Working drawings of architectural, mechanical, structural, and electrical aspects of building are completed

- Bidding specifications are written

  NOTE: Bidding specifications establish where and when a contractor must submit a bid, what substitutions are allowed in the bid, and what amount and type of insurance will be required of the contractor.

- Bid forms are written

  NOTE: *Bid forms* are forms contractors use to quote their bids concerning exact construction costs and timeframes for completion of construction.

d. **Phase 4: Bidding and negotiation**

- Plans are issued to crontractor

- Bid proposal is accepted from contractor

- Negotiations begin with contractor to determine specifications to be included in the final construction contract

- Final construction contract is drafted

e. **Phase 5: Construction**

NOTE: During the construction phase, the contractor/subcontractor begins construction on a contracted date, interprets drawings and specifications, uses approved construction techniques, and completes work on contracted date. However, the architect/engineer also has the general responsibilities listed below.

- Pre-construction conference is conducted between client, architect, and general contractor

- Shop drawings for fabrication are submitted

- Job-site observations are made to approve contractor's performance, approve and supervise all changes, and inform client of project status

- Project is closed out and final site observations are made

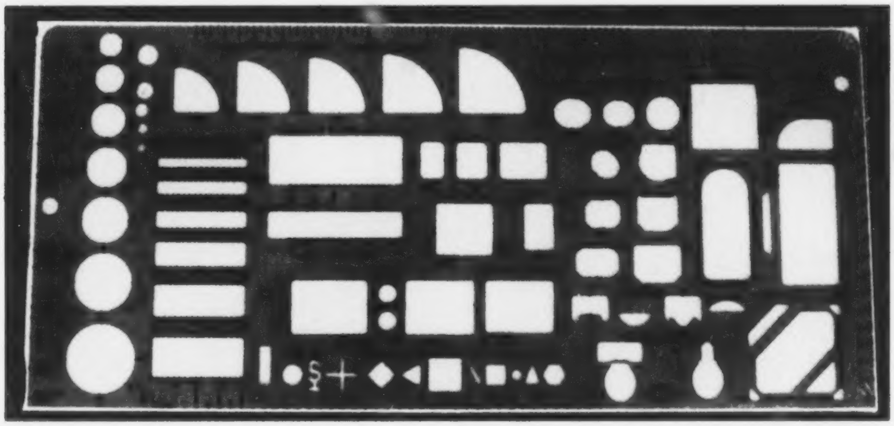
4. **Architectural-drafting tools and materials and their descriptions**

a. **Architectural-symbol template** (see Figure 1)—Provides to-scale templates for drawing door-swing, bathroom-fixture, kitchen-appliance, and cabinetry symbols

NOTE: Architectural-symbol templates are the most commonly used architectural tool. The templates are available in several scales, including ¼" = 1'-0" and ⅛" = 1'-0".

INFORMATION SHEET

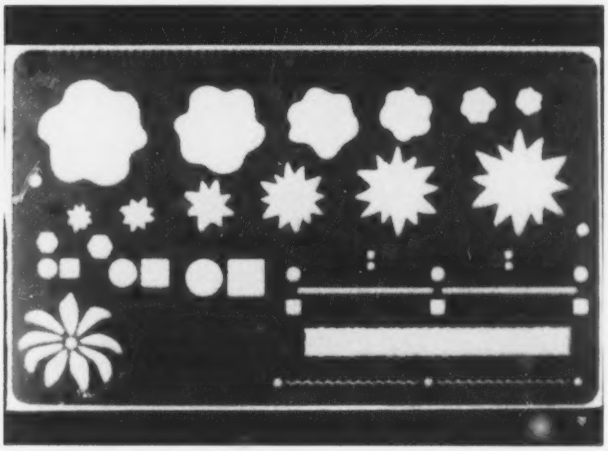
FIGURE 1



b. **Landscape template** (Figure 2)—Provides to-scale templates for drawing landscaping symbols such as trees, shrubs, fences, posts, and hedges

NOTE: Landscape templates are commonly used when drawing site plans, which depict the land surrounding a structure. These templates are also produced in various scales.

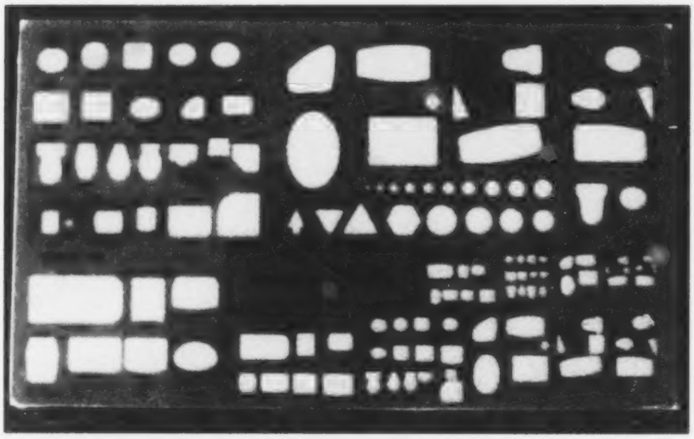
FIGURE 2



INFORMATION SHEET

c. **Plumbing template** (Figure 3)—Provides to-scale templates for drawing standard plumbing symbols such as shower stalls, urinals, toilets, and water fountains

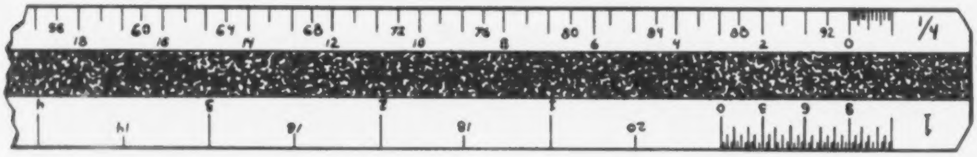
FIGURE 3



d. **Architectural scale** (Figure 4)—Provides common fractional-inch scales (⅛", ¼", ½", 1⁄16") where fractional-inch increments represent a unit of measure equal to 1 foot in length

EXAMPLE: ¼" = 1'-0"

FIGURE 4

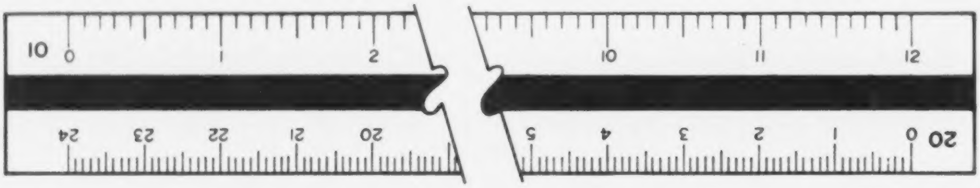

56
18
60
16
64
14
68
12
72
10
76
8
80
6
84
4
88
2
92
0
1/4

INFORMATION SHEET

e. **Civil engineers scale** (Figure 5)—Provides common scales (10', 20') where 1-inch increments represent a unit of measure equal to a given number of feet

EXAMPLE: 1″ = 10'

FIGURE 5

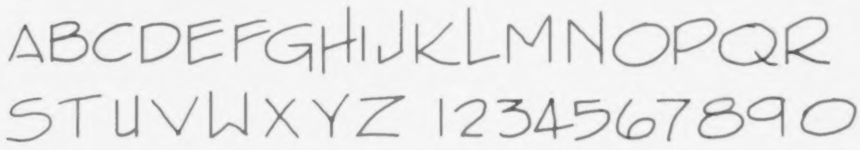

10
0
1
2
10
11
12
24
23
22
21
20
5
4
3
2
1
0
20

5. **Architectural lettering styles and their characteristics**

NOTE: The following lettering styles are all accepted in the architectural industry; however, the triangle, extended, and variation styles are, by far, the most prevalent.

a. **Triangle** (Figure 6)—Letters with vertical strokes (H, L, N, etc.) drawn with a straightedge (drafting triangle) and extended higher than top of letters with rounded strokes; letters with rounded strokes (B, C, D, etc.) drawn freehand and in an oval shape

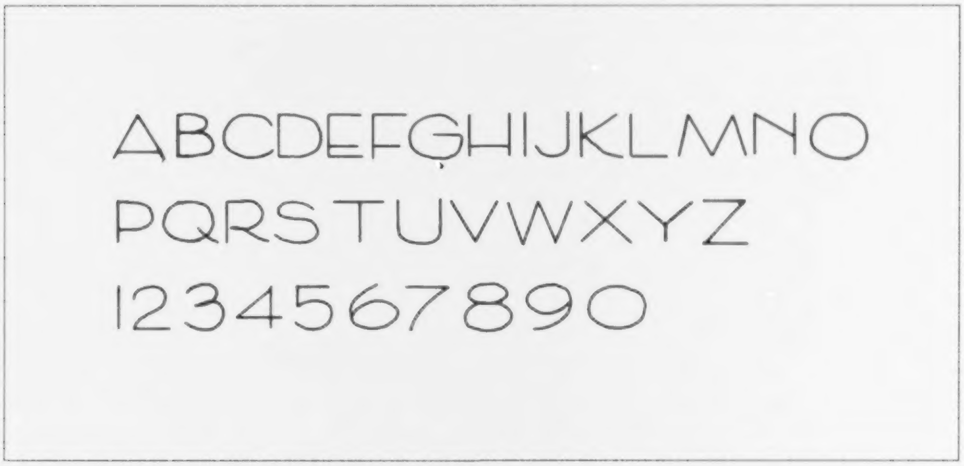
FIGURE 6


ABCDEFGHIJKLMNOPQR
STUVWXYZ 1234567890

INFORMATION SHEET

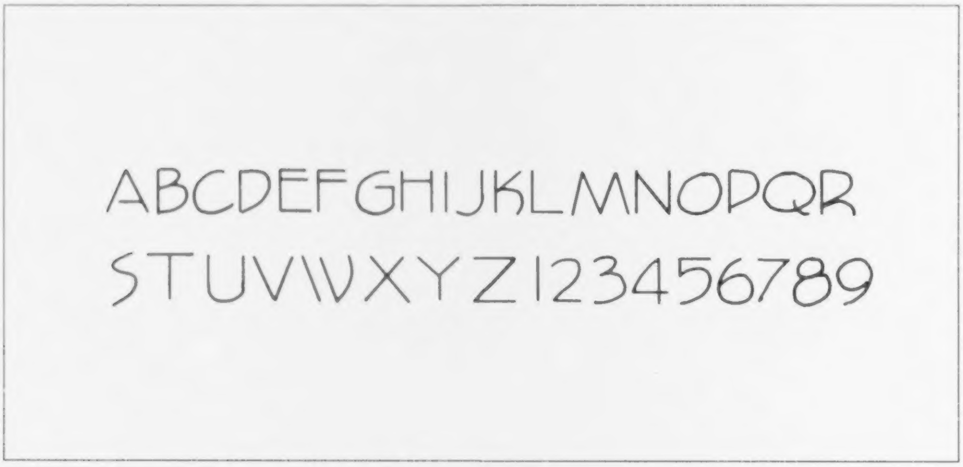
b. **Extended** (Figure 7)—Freehand letters drawn so that top portions of letters extend downward and widths of letters are widened, making letters appear top-heavy and almost as wide as they are high

FIGURE 7


ABCDEFGHIJKLMNO
PQRSTUVWXYZ
1234567890

c. **Variation** (Figure 8)—Freehand letters drawn with high horizontal strokes on letters E, F, and H; with rounded ends on letters K, Q, R, and S; and with extended widths on all letters so that letters appear wider than normal

FIGURE 8

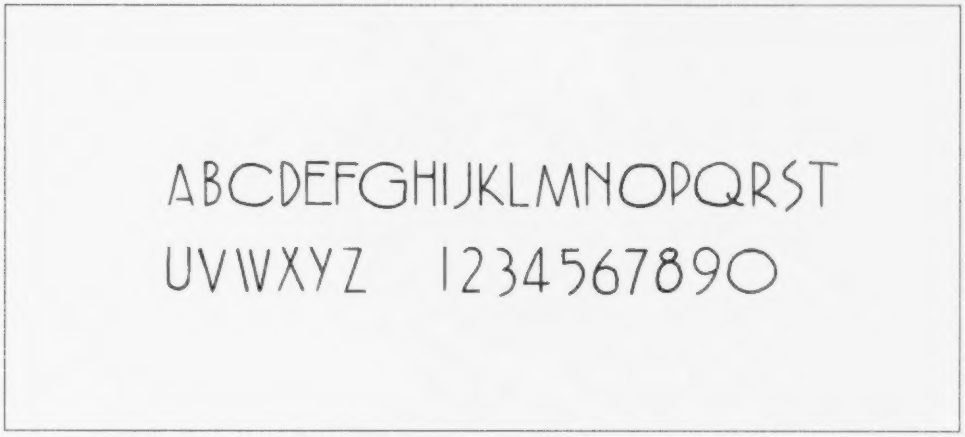

ABCDEFGHIJKLMNOPQR
STUVWXYZ123456789

INFORMATION SHEET

d. **Kabel modern** (Figure 9)—Freehand letters drawn with high horizontal strokes on letters E, F, and H; with rounded ends on letters K, Q, R, and S; with large ovals on circular letters; and with condensed widths on all other letters so that letters appear very narrow

NOTE: The kabel modern style is an adaptation of the variation lettering style.

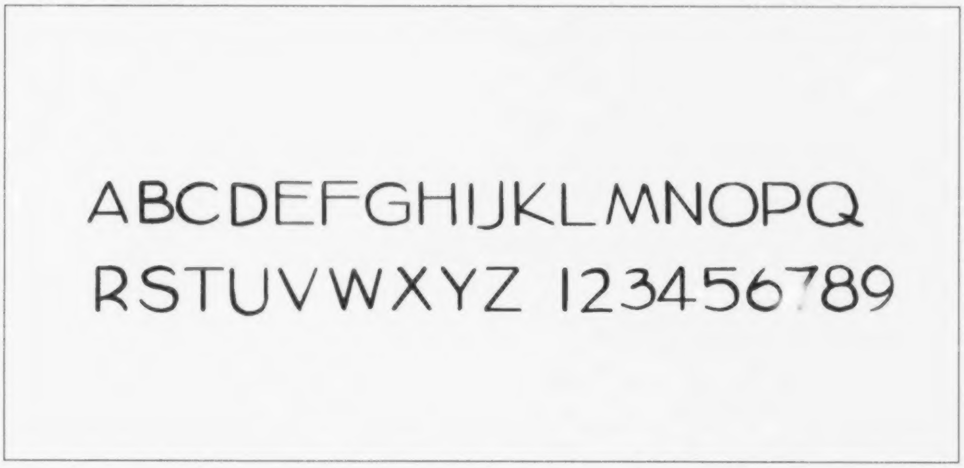
FIGURE 9


ABCDEFGHIJKLMNOPQRST
UVWXYZ 1234567890

e. **Chisel** (Figure 10)—Structured freehand letters drawn with emphasis strokes created with a widened pencil width

NOTE: The chisel lettering style is normally used to emphasize headings, titles, etc.

FIGURE 10

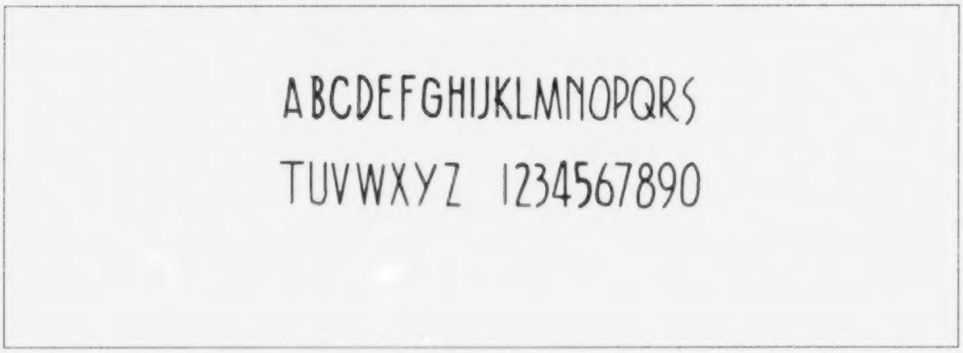

ABCDEFGHIJKLMNOPQ
RSTUVWXYZ 123456789

INFORMATION SHEET

f. **Condensed** (Figure 11)—Structured freehand letters drawn approximately three times as high as they are wide so that letters appear very narrow

NOTE: One advantage to using the condensed lettering style is that many letters can be placed in a small area.

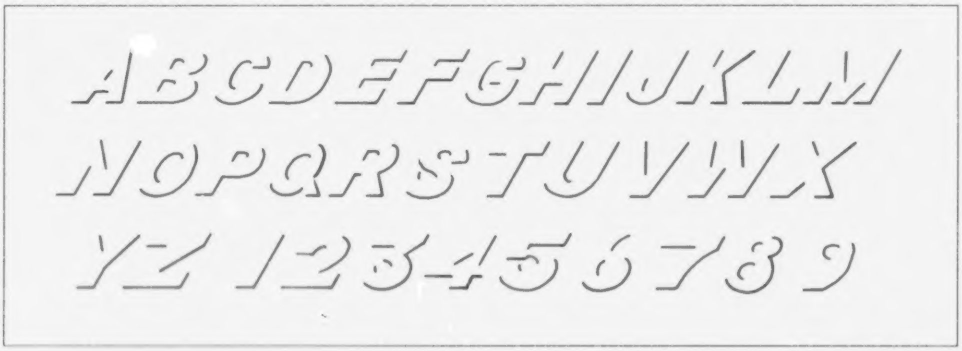
FIGURE 11



g. **Shadow** (Figure 12)—Letters drawn with the aid of a stencil and created by omitting selected lines from stencil pattern

NOTE: Shadow-style letters are used only on rare occasions, such as to highlight drawing titles or project names on cover sheets.

FIGURE 12



6. **Descriptions of standard references and resource materials used in the design and construction industry**

a. **Architectural Graphic Standards**—Industry-recognized handbook used as a resource for standard dimensions, construction methods, materials, and structural data

INFORMATION SHEET

b. **Sweets Architectural Catalog File**—Industry-recognized catalog file used as a resource for manufacturers' product information

c. **Uniform Building Code** (UBC)—Manual of design and construction criteria established by the International Conference of Building Officials and used by regional building departments as a guide for the approval of architectural plans and specifications

d. **Uniform Mechanical Code** (UMC)—Manual established by the International Conference of Building Officials and used as a resource for standards and installation guidelines pertaining to mechanical systems

e. **Uniform Plumbing Code** (UPC)—Manual established by the International Association of Plumbing and Mechanical Officials and used as a resource for standards and installation guidelines pertaining to plumbing systems

f. **American Electricians' Handbook**—Industry-recognized handbook used as a resource for standards and criteria concerning electrical applications in the construction industry

7. **Standard architectural abbreviations**

NOTE: The following abbreviations are taken from the American National Standards Institute Adopted List—Standard Y 1.1. The abbreviations are commonly used in the standard references and resource materials listed in Objective 6.

a. **Arch**—Architecture, architectural

b. **Assn**—Association

c. **ANSI**—American National Standards Institute

d. **Co**—Company

e. **Contr**—Contract, contractor

f. **Const**—Construction

g. **Engr**—Engineer

h. **Spec**—Specification

i. **Schem**—Schematic

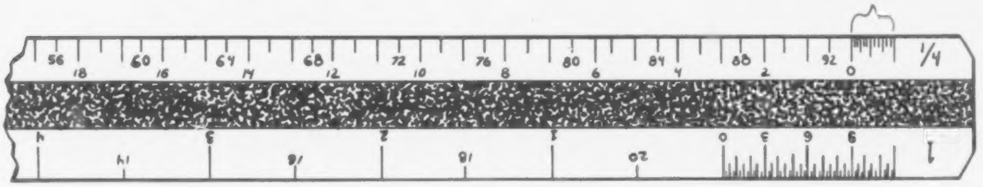
j. **AIA**—American Institute of Architects

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

STUDENT SUPPLEMENT 1—GUIDELINES FOR USING AN ARCHITECTURAL SCALE

An architectural scale is generally multisided, and each side is marked with a different scale. See Figure 1. These scales use common fractions (⅛", ¼", ½", 1⁄16") as a unit of measure equal to 1 foot (1'-0") in length. For example, when you are drawing a building using the side of the architect's scale marked ¼, each ¼-inch increment used to draw a line equals 1 foot of the actual size of the building. Also note on Figure 1 that the zero end of each scale (the scale to the right of the zero) contains 12 equal graduations. These graduations represent inch values you will use to achieve even greater accuracy when drawing with an architectural scale. For example, one graduation to the right of the zero on the ¼ scale equals 1 inch.

FIGURE 1

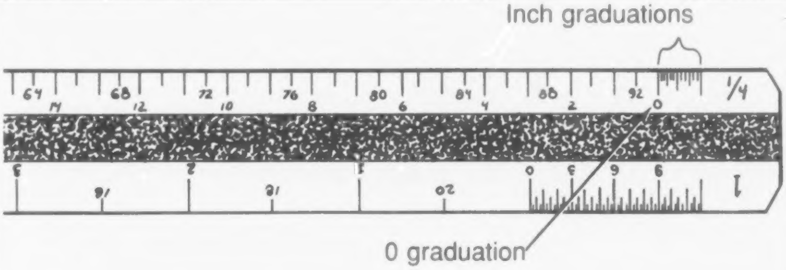

Each graduation equals 1 inch.
56
18
60
16
64
14
68
12
72
10
76
8
80
6
84
4
88
2
92
0
1/4

Use the four steps in the following example to help you learn to draw an accurate line using both inch graduations and foot increments on a scale.

Let's say you wish to use the ¼-inch scale to draw a line that represents 4'-3" in length.

Step 1: Locate the zero graduation and the inch graduations to the right of the zero on the ¼ scale (Figure 2).

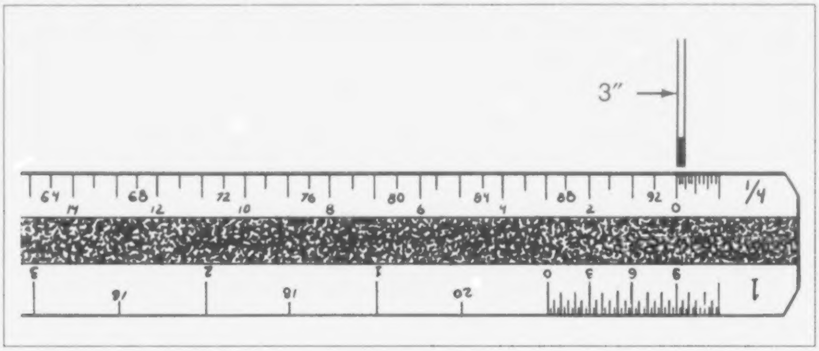
FIGURE 2


Inch graduations
64
14
68
12
72
10
76
8
80
6
84
4
88
2
92
0
1/4
0 graduation

STUDENT SUPPLEMENT 1

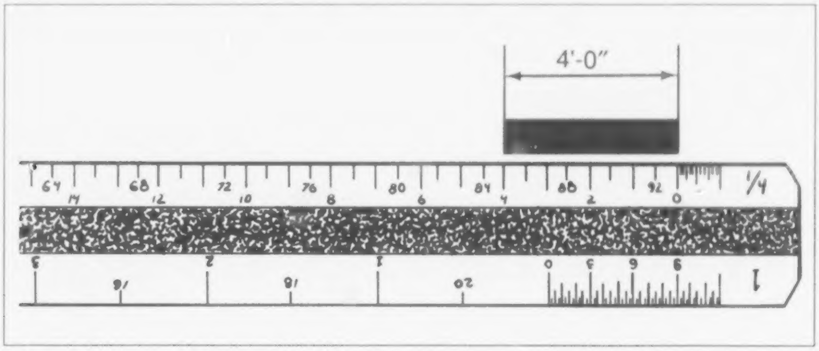
Step 2: Count three graduations to the right of the zero to locate the graduation equalling 3 inches (Figure 3).

FIGURE 3


3″
64
68
72
76
80
84
88
92
14
12
10
8
6
4
2
0
1/4

Step 3: Locate the 4 to the left of the zero (Figure 4). This graduation represents 4 feet on the ¼-inch scale.

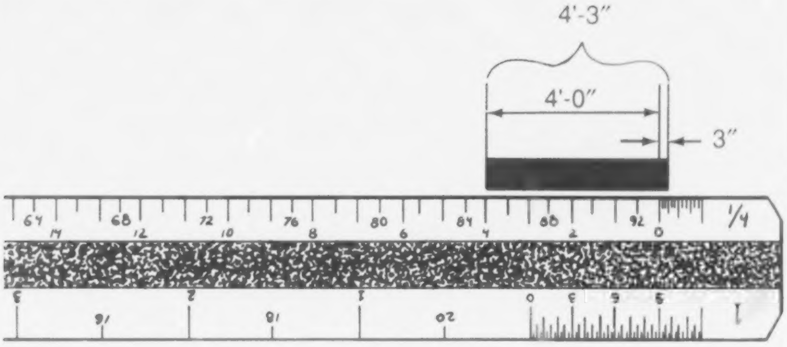
FIGURE 4


4'-0″
64
68
72
76
80
84
88
92
14
12
10
8
6
4
2
0
1/4

Step 4: Place the scale on the drawing paper, and beginning at the 3-inch graduation to the right of the zero, complete a line that ends at the 4-foot graduation to the left of the zero (see Figure 5 on the next page). You have completed a line representing 4'-3″ on a ¼-inch scale.

STUDENT SUPPLEMENT 1

FIGURE 5


4'-3"
4'-0"
3"
64
68
72
76
80
84
88
92
14
12
10
8
6
4
2
0
1/4

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

STUDENT SUPPLEMENT 2—LETTERING GUIDELINES

- Never change or stylize standard letter styles. You may not be the only drafter assigned to a project, and you must use standard letters so that all the lettering on a drawing will look like one person did it, regardless of how many people actually did the lettering.

- You should always prepare your drafting media carefully by drawing light guidelines that are not visible when the drawing is held at arm's length. Drawings are often reproduced and guidelines should be drawn in such a way that they will not print when reproduced.

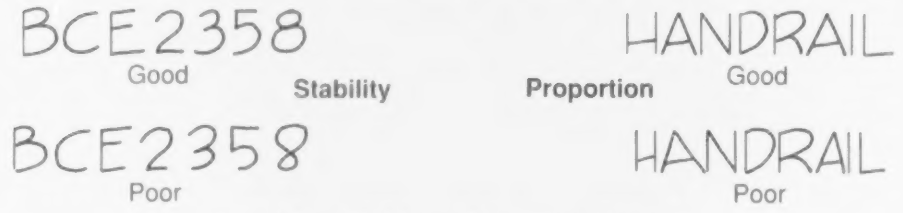
- While guidelines should be light enough not to reproduce, lettering should be sharp and dense (dark) enough to reproduce well.

- All lettering should be in proportion and *stable*, not heavy and unstable. See Figure 1-a.

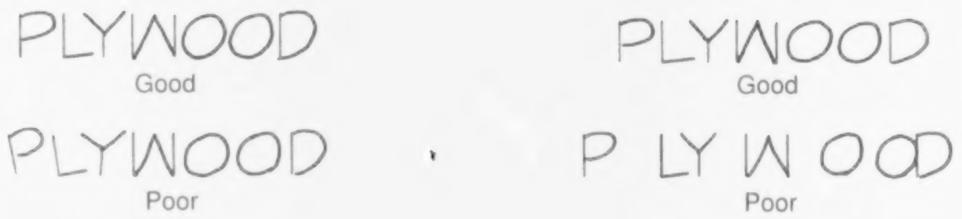
- All lettering strokes should be consistent around a vertical line. See Figure 1-b.

- All spacing should appear visually equal; poor spacing will destroy even the best-looking lettering. See Figure 1-c.

FIGURE 1


BCE2358
Good
Stability
Proportion
HANDRAIL
Good
BCE2358
Poor
HANDRAIL
Poor

(a) **Stable and in proportion**


PLYWOOD
Good
PLYWOOD
Good
PLYWOOD
Poor
P LY W OOD
Poor

(b) **Consistent vertical strokes**

(c) **Visually equal spacing**

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

STUDENT SUPPLEMENT 3—GUIDELINES FOR USING STANDARD ARCHITECTURAL REFERENCES AND RESOURCE MATERIALS

Architectural Graphic Standards

Architectural Graphic Standards (see Figure 1) is formatted into major sections that are further divided into specific chapters. Sections and chapter headings can be skimmed by subject area when you need general information concerning a subject. However, to find more specific information, first consult the extensive index at the back of the book to find page numbers for that topic.

FIGURE 1

Graphic
STANDARDS
THE AMERICAN INSTITUTE OF ARCHITECTS

Sweets Architectural Catalog File

Sweets format is very unique. The file contains 16 divisions of catalogs, sequenced by an alphanumeric coding system. To find a particular product entry within the 16 divisions, you must first know the alphanumeric code for that product.

A master index accompanies the 16 divisions of catalogs. The master index is divided into three sections, referencing products by firm name, by product name, and by trade name. The entries in any of the three sections of the index will provide you with the alphanumeric code used in locating a product within the catalog.

To use the index to find the complete code for a specific product (concrete materials provided by the Euclid Chemical Company, for example) begin by locating the general-subject heading for the product (in this case, *concrete*). In the entry for each general subject you can obtain a five-digit numerical code (03010 is the five-digit code for *concrete*).

Next, look under the general-subject heading until you find the entry for the specific topic (the Euclid Chemical Company), where you will be given an alphabetical code to be added to the five-digit code (in this case, EUC). Use the combined alphanumeric code (03010/EUC) to locate entries in the 16-division catalog.

STUDENT SUPPLEMENT 3

Uniform Code Books

The uniform code books—*Uniform Building Code*, *Uniform Mechanical Code*, and the *Uniform Plumbing Code* (see Figure 2)—all use the same format. Each book contains chapters dealing with broad topics that are divided into specific topic areas called *sections*. To locate topics within chapters and sections, you must obtain a three-digit code or reference number. The first digit in the reference number corresponds to the chapter and the last two numbers correspond to the proper section (for example, UPC, Chapter 9, "Plumbing Fixtures," Section 907 concerns "placement of plumbing fixtures.") Section numbers are sometimes narrowed even further with alpha characters (907 [a], 907 [b]). An extensive index at the back of the book will provide you with the appropriate section number for the specific topic you wish to locate.

American Electricians' Handbook

The *American Electricians' Handbook* (see Figure 3) contains eight major divisions, called *articles*, which are subdivided into sections. Entries in the book are located using a three-digit code. The first number of each code corresponds to the article number (100, 200, 300, through 800). The last two digits correspond to the section within the article. Sections are numbered sequentially (310, 320, 330, etc.). Sections contain specific information relating to the topic of the article.

FIGURE 2

UNIFORM
BUILDING
CODE
1988
EDITION

FIGURE 3

American
Electricians'
Handbook
Seventh Edition
Terrell Croft
Wilford Summers
75th

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

ASSIGNMENT SHEET 1—USE AN ARCHITECTURAL SCALE

Name ____________________ Score ____________

Introduction

In architectural drawings, the actual size of a building and all of its components must be scaled down (reduced in size) so that they will fit on the drawing paper. You will use an architectural scale to help you accomplish this without the necessity of making many time-consuming mathematical calculations.

Read the information in Student Supplement 1, "Guidelines for Using an Architectural Scale," before completing the exercise below.

Exercise

Directions

Read each of the items below, noting the scale indicated in each item. Then in the space below each item, draw lines to the lengths indicated.

1. Using the ⅛" = 1'-0" scale, draw a line equal to 14'-0".
2. Using the ¼" = 1'-0" scale, draw a line equal to 7'-6".
3. Using the ½" = 1'-0" scale, draw a line equal to 2'-3".
4. Using the 1" = 1'-0" scale, draw a line equal to 1'-7".

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ASSIGNMENT SHEET 1

5. Using the 3⁄16″ = 1'-0″ scale, draw a line equal to 9'-0″.

6. Using the ¾″ = 1'-0″ scale, draw a line equal to 2'-11″.

7. Using the 1 ½″ = 1'-0″ scale, draw a line equal to 2'-3 ½″.

8. Using the 3″ = 1'-0″ scale, draw a line equal to 3 ¾″.

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

ASSIGNMENT SHEET 2—PRACTICE LETTERING USING TRIANGLE, EXTENDED, AND VARIATION STYLES

Name ______________________________ Score ____________

Introduction

Being able to letter well is one of the most important skills a drafter can develop in order to get that first job and to demonstrate pride in your work.

Lettering is so important to companies hiring drafters that many require a separate lettering sample accompany each applicant's application form. Why do company's place so much emphasis on an applicant's lettering skills? Approximately 20 percent of a drafter's time is spent in lettering, and a drafter who letters both neatly and quickly conserves time—and money—for the company.

Beyond considerations for getting a job, drafters who have pride in their work learn to letter well. Lettering greatly affects the overall appearance of a drawing, and drafters who letter very carefully can add much to the quality of each drawing they produce.

This assignment sheet and Student Supplement 2, "Lettering Guidelines" are designed to help you learn the three most commonly used lettering styles: triangle, extended, and variation. Read Student Supplement 2 before completing the following exercises.

Exercises

Part A **Tracing**

Directions

Using a separate sheet of vellum for each letter style, practice tracing the triangle-, extended-, and variation-style letters and numerals on the following pages.

ASSIGNMENT SHEET 2

Triangle-style letters and numerals

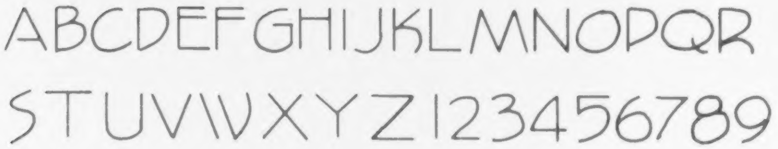
ABCDEFGHIJKLMNOPQR
STUVWXYZ 1234567890

Extended-style letters and numerals

ABCDEFGHIJKLMNO
PQRSTUVWXYZ
1234567890

ASSIGNMENT SHEET 2

Variation-style letters and numerals



Part B	**Lettering using triangle-style letters and numerals**
Directions	Tape a 8 ½″-x-11″ size-*A* sheet of vellum to a drafting table, and align sheet with drafting machine. Prepare a lead pointer for lettering, and then, lightly construct ¼-inch guidelines across the vellum sheet. (One-fourth inch is a standard lettering height for architectural drawings.) Letter the entire alphabet and numerals in the triangle style, making sure that you stay within the ¼-inch guidelines and follow the general guidelines for lettering presented in Student Supplement 2 as well as the specific guidelines for triangle-style letters presented in Objective 5 of the information sheet.
Part C	**Lettering using extended-style letters and numerals**
Directions	Tape a 8 ½″-x-11″ size-*A* sheet of vellum to a drafting table, and align sheet with drafting machine. Prepare a lead pointer for lettering, and then, lightly construct ¼-inch guidelines across the vellum sheet. Letter the entire alphabet and numerals in the extended style, making sure that you stay within the ¼-inch guidelines and follow the general guidelines for lettering presented in Student Supplement 2 as well as the specific guidelines for extended-style letters presented in Objective 5 of the information sheet.

ASSIGNMENT SHEET 2

Part D	**Lettering using variation-style letters and numerals**
Directions	Tape a 8 ½"-x-11" size-*A* sheet of vellum to a drafting table, and align sheet with drafting machine. Prepare a lead pointer for lettering, and then, lightly construct ¼-inch guidelines across the vellum sheet. Letter the entire alphabet and numerals in the variation style, making sure that you stay within the ¼-inch guidelines and follow the general guidelines for lettering presented in Student Supplement 2 as well as the specific guidelines for variation-style letters presented in Objective 5 of the information sheet.

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

ASSIGNMENT SHEET 3—USE STANDARD REFERENCES AND RESOURCE MATERIALS

Name ______________________________ Score ______________

Introduction

The following references and resource materials are those recognized as the standard references used throughout the design and construction industry; therefore, the ability to use these books is an essential skill. Use the guidelines presented in Student Supplement 3 and the exercises in this assignment sheet to learn to use these valuable reference tools.

Exercises

Part A **Architectural Graphic Standards**

Directions

Use *Architectural Graphic Standards*, 8th edition, to find the correct answers for each of the following questions. Write your answers on the blanks provided.

1. What is the minimum permissible tread length for a concrete stairway?

   Minimum permissible tread length ______________

2. A soil percolation test requires that the soak hole be continually refilled for how many consecutive hours?

   Number of consecutive hours ______________

3. What is the minimum number of handicap parking stalls required per 100 stalls?

   Minimum number of stalls ______________

Part B **Sweets Catalog File Master Index**

Directions

Use the 1988 edition of *Sweets Catalog File Master Index* to determine the correct answers to the following questions. Write your answers on the blanks provided.

1. What five-digit code would be used to research information concerning concrete formwork?

   Five-digit code ______________

ASSIGNMENT SHEET 3

2. Section 13032 of the catalog file lists ten manufacturers. What type of product do these manufacturers construct?

   Product ________________________________

3. If using the "firm name" portion of the master index, what code would you use to find information about Georgia Marble Company's marble-tile product?

   Code ________________________________

Part C **Uniform Code Books**

Directions Use the uniform code book indicated in each item below to answer the following questions. Write your answers on the blanks provided.

1. What section of the *Uniform Building Code* contains information concerning the minimum dimensions for ceiling heights?

   Section ________________________________

2. What three types of chimneys are dealt with in Chapter 9, "Venting of Appliances," of the *Uniform Mechanical Code*?

   Types of chimneys ________________________________

3. Section 907 (e) of the *Uniform Plumbing Code* sets the minimum distance that a bathroom urinal may be placed from its center to any side wall or partition. What is that distance?

   Minimum distance ________________________________

Part D **American Electricians' Handbook**

Directions Use the 1987 edition of the *American Electricians' Handbook* to determine the correct answer for the following question. Write your answer on the blank provided.

1. Article 200 of the handbook deals with the use of grounded connectors. What section number gives specific information about grounded-fault-interrupter circuits?

   Section number ________________________________

INTRODUCTION TO ARCHITECTURAL DRAFTING
UNIT 1

WRITTEN TEST

Name ______________________________ Score ______________

1. Match terms associated with architectural drafting to their correct definitions. Write the numbers on the blanks provided.

______a. The art and science of planning and designing buildings

______b. Set of drawings used to construct a proposed building or structure

______c. Initial architectural work phase during which project requirements are determined and preliminary drawings are created

______d. Set of precisely written documents that describe the contract parameters and quality of work to be performed during construction of a project

______e. Architectural work phase during which bids and negotiated proposals are sought as the basis for awarding construction contract

______f. Drawing that defines the boundaries of the land on which a building is to be located

______g. Composite of all working drawings and written specifications associated with a specific construction project

______h. Person or firm that undertakes responsibility for the performance of construction work

______i. Drawing indicating building size and interior-room arrangement

1. Architecture
2. Bidding phase
3. Contractor
4. Construction documents
5. Schematic design
6. Specifications
7. Site diagram
8. Working drawings
9. Floor plan

WRITTEN TEST

2. Match typical levels of architectural job titles to their associated responsibilities and qualifications. Write the numbers on the blanks provided. Responsibilities and qualifications continue on the next page.

_____a. **Responsibilities**

Runs prints and maintains drawing files, inks all lines and lettering on drawings as required, works under supervision of chief drafter or architect

Qualifications

Has obtained high-school diploma or is successfully working toward one, has successfully completed coursework in a vocational architectural-drafting program, has successfully completed one year of algebra and one year of geometry, has maintained a good school-attendance record, can supply good character references

_____b. **Responsibilities**

Uses handbooks and reference materials to determine design specifications and correct data concerning building materials to be used, makes mathematical computations involving strength of structural materials

Qualifications

Has successfully completed approved six-year bachelor's degree program in engineering, has successfully completed engineer-in-training (EIT) examination, has successfully completed apprenticeship program under the supervision of a licensed engineer, has successfully completed practicing-engineer (PE) examination for engineering specialty area

1. Architectural drafter trainee
2. Architectural drafter
3. Architectural designer
4. Licensed architectural engineer
5. Licensed architect

WRITTEN TEST

_____c. **Responsibilities**

Prepares pictorial and working drawings, makes reproducible drawings from architect's or designer's sketches, prepares drawing schedules from written specifications

Qualifications

Has obtained high-school diploma, has successfully completed two or more years in a vocational architectural-drafting program, has successfully completed one year of algebra and one year of geometry, can supply good character references

_____d. **Responsibilities**

Develops design concepts, proposals, and presentations for the purpose of acquiring projects for firm, determines design specifications, makes job-site observations, supervises subordinates, manages business aspects of project

Qualifications

Has successfully completed bachelor's degree in architecture from a National Architectural Accrediting Board-approved program, has successfully completed three-year apprenticeship program under supervision of licensed architect, has successfully completed both theory and design-problem divisions of the state-board examination for architects

_____e. **Responsibilities**

Sketches plans for drafters, develops design layouts, produces complex detail drawings

Qualifications

Has successfully completed an associate degree in a technical area, has completed a minimum of five years of drafting experience, can supply good work credentials

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WRITTEN TEST

3. Identify architectural work phases according to descriptions of work completed at each phase. Write the correct phase numbers, 1 through 5, on the blanks provided beside each description.

Phase ______ a. Written description of type, quantity, and quality of materials to be used in building construction is completed; survey is conducted and accurate drawing of proposed building site is completed; working drawings of architectural, mechanical, structural, and electrical aspects of building are completed; bidding specifications are written; bid forms are written

Phase ______ b. Pre-construction conference is conducted between client, architect, and general contractor; shop drawings for fabrication are submitted; job-site observations are made to approve contractor's performance, approve and supervise all changes, and inform client of project status; project is closed out and final site observations are made

Phase ______ c. Rough site diagram and floor plans are developed; implications of local zoning codes and regulations are examined; estimate of overall construction costs is completed; statements of architect's design concept and engineering requirements are completed; color presentation drawings and elaborate visual aids are completed to help gain client approval

Phase ______ d. Plans are issued to contractor; bid proposal is accepted from contractor; negotiations begin with contractor to determine specifications to be included in the final construction contract; final construction contract is drafted

Phase ______ e. Schematic design is refined; precise line drawings and written specifications are completed; cost analysis is refined

4. State descriptions of the following architectural-drafting tools and materials. Write your answers on the blanks provided.

a. Architectural scale ____

____

____

b. Landscape template ____

____

____

WRITTEN TEST

c. Architectural-symbol template ______

d. Plumbing template ______

e. Civil engineers scale ______

5. State characteristics of the following architectural lettering styles. Write your answers on the blanks provided.

a. Extended ______

b. Variation ______

c. Kabel modern ______

d. Chisel ______

WRITTEN TEST

e. Triangle

f. Condensed

g. Shadow

6. State descriptions of each of the standard references and resource materials listed below. Write your answers on the blanks provided.

a. **American Electricians' Handbook**

b. **Architectural Graphic Standards**

c. **Uniform Mechanical Code** (UMC)

WRITTEN TEST

d. **Sweets Architectural Catalog File** ______________________________

e. **Uniform Building Code** (UBC) ______________________________

f. **Uniform Plumbing Code** (UPC) ______________________________

7. Interpret the standard architectural abbreviations printed in bold italics in each of the following statements. On the blanks provided, spell out the correct complete word(s) for each abbreviation.

   a. The office building was designed by a prominent ***arch*** firm in Chicago.

      Complete word ______________________________

   b. The National ***Assn*** of Homebuilders sponsors state and local chapters in addition to its national organization.

      Complete word ______________________________

   c. The standard that applies to standard abbreviations is ***ANSI*** standard Y1.1.

      Complete words ______________________________

   d. The construction contract was awarded to the Clear Creek Construction ***Co***.

      Complete word ______________________________

   e. Williams Engineering Firm was selected as the project's primary ***contr***.

      Complete word ______________________________

WRITTEN TEST

f. The first day of June was set forth as the date ***const*** was to be completed.

Complete word ____________________

g. The mechanical ***engr*** on the project was acknowledged as the best in the state.

Complete word ____________________

h. The written ***spec*** took precedent over the drawing plans.

Complete word ____________________

i. The preliminary ***schem*** design was not approved by the owner.

Complete word ____________________

j. The ***AIA*** can be consulted for up-to-the minute career information.

Complete words ____________________

ARCHITECTURAL BUILDING MATERIALS
UNIT 2

UNIT OBJECTIVE

After completing this unit, the student should be able to define or describe common building materials and identify and draw standard symbols used to represent these building materials in architectural drawings. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with architectural building materials to their correct definitions.
2. List common types of architectural building materials.
3. Discuss the characteristics of lumber used in construction.
4. Match types of wood products commonly used in construction to their correct definitions.
5. Match types of steel products commonly used in construction to their correct descriptions.
6. Define the terms *cement* and *concrete*.
7. Match types of masonry products commonly used in construction to their correct definitions.
8. Match types of fasteners commonly used in construction to their correct descriptions.
9. Match types of glazing products commonly used in construction to their correct descriptions.
10. Describe types of thermal-insulation materials commonly used in construction.
11. Match thermal-insulation applications to their correct descriptions.
12. Match types of damp-proofing and drainage materials commonly used in construction to their correct descriptions.
13. Label common construction-material symbols used on architectural drawings.
14. Interpret typical designations for common structural-steel shapes. (Assignment Sheet 1)
15. Practice drawing common building-material symbols. (Assignment Sheet 2)

ARCHITECTURAL BUILDING MATERIALS
UNIT 2

SUGGESTED ACTIVITIES

Preparation

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery and Application" section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.
- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section.
- Duplicate teacher supplements included in this unit, as required.
- Prepare classroom and lab. Put up posters, charts, and signs; display articles and other references related to the objectives of this unit.

Delivery and Application

Unit introduction

- Provide students with objective sheet. Discuss unit and specific objectives.
- Show the film *Modern Construction Technology*. Discuss the film, explaining the evolution of building materials and their uses in construction today. Give examples of the use of "old" building materials (brick, stone, wood) and of "new" building materials (steel alloys, extruded plastics, tempered glass). Explain how these old and new materials are used in conjunction today to create specific appearances and styles.
- Show the film *Planning—Structures and Their Designs*, Part 1 of the *Light Commercial Construction Series*.
- Provide students with information sheet and assignment sheets.

Objective 1 Match terms associated with architectural building materials to their correct definitions.

- Show examples that illustrate terms and make examples available in the classroom.

SUGGESTED ACTIVITIES

- Use Figure 1 to illustrate your discussion of the term *truss*.

Objective 2 List common types of architectural building materials.

- Explain to students that these are the basic groups of building materials that will be discussed in this unit and that these are the types of building materials most commonly represented on architectural drawings.
- Use Teacher Supplement 1, "Sample Wall-Section Drawing" to illustrate your explanation.

Objective 3 Discuss the characteristics of lumber used in construction.

- Read with students the items and notes in this objective. Explain the terms *hardwood, softwood, grade, nominal size, actual size, plain-sawed,* and *quarter-sawed* as they are applied to wood products. Use Figure 2 and Table 1 to illustrate your explanation. Also have examples of wood products for the students to examine and take measurements from.
- Hand out copies of Teacher Supplement 2, "Dimension-Lumber Grades," and Teacher Supplement 3, "American Plywood Association Veneer Grades," to help illustrate your discussion of the term *grade*.

Objective 4 Match types of wood products commonly used in construction to their correct definitions.

- Read with students the notes with each item in the objective. Discuss the applications of wood as a construction material and the advantages and disadvantages of using wood as a construction material.
- Use Figure 3 to illustrate your discussion of the term *plywood panels*.

Objective 5 Match types of steel products commonly used in construction to their correct descriptions.

- Discuss with students the various structural-steel shapes and their construction applications. Use Table 2 and Figures 4 and 5 to illustrate your discussion.
- Use Student Supplement 1, "Typical Designations for Structural-Steel Shapes," to discuss how to interpret those designations.

SUGGESTED ACTIVITIES

- Discuss Assignment Sheet 1, "Interpret Typical Designations for Common Structural-Steel Shapes." Read the introduction and directions and answer any questions students may have. Have students complete Assignment Sheet 1.

Objective 6 Define the terms *cement* and *concrete.*

- Read with students the items in the objective and the notes associated with each item. Carefully explain what concrete is and discuss its widespread applications in the construction industry.
- Using the artwork in Figure 6, discuss how concrete of different strengths, finishes, colors, etc., can be created simply by varying the amounts of the basic concrete elements.

Objective 7 Match types of masonry products commonly used in construction to their correct definitions.

- Read with students the items in the objective and the notes associated with each item. Use Figures 7 through 9 and Table 3 to illustrate your discussion.
- Explain masonry's longevity and popularity as a construction material. Illustrate this idea by having students list as many masonry products as they can think of that were used in constructing both the interior and exterior of their school (block walls, brick walls, mortar, interior floor tiles, wall tiles, etc.). Compile a master list on the chalkboard, emphasizing masonry's flexibility and widespread applications.

Objective 8 Match types of fasteners commonly used in construction to their correct descriptions.

- Read with students the items in the objective and the notes associated with each item. Explain the various types of construction fasteners and their applications.
- Use Figures 10 through 13 to illustrate the designs and installation of the various types of fasteners used in construction.
- Have students bring in examples of fasteners from tool boxes at home, display their examples, and discuss the applications for each of the fasteners they have obtained. Explain that commercial fasteners are much like the fasteners they may find at home except for their larger size, which is required to support the greater weight loads required. Display actual commercial fasteners to illustrate this size comparison.

SUGGESTED ACTIVITIES

Objective 9 Match types of glazing products commonly used in construction to their correct descriptions.

- Discuss the wide variety of glazing products available today and their widespread use in commercial construction in order to create visually striking exteriors and interiors.
- Discuss each type of glass product listed in the objective and have students give examples of where they may have seen such products used.
- Display actual samples of as many plastic glazing products as possible.

Objective 10 Describe types of thermal-insulation materials commonly used in construction.

Objective 11 Match thermal-insulation applications to their correct descriptions.

- Read with students the descriptions discussed in Objectives 10 and 11. Explain the advantages and disadvantages of each type of insulating material discussed as well as their common applications.
- Explain the term *R-value* in relation to the insulating value of the various materials discussed. Emphasize that the higher the R-value of an insulating material, the higher the insulating ability of the material. Hand out copies of Teacher Supplement 4, "Insulation R-Values," to help illustrate your explanation.
- List common construction materials and their corresponding R-values.
- Display actual samples of as many insulating materials as possible.

Objective 12 Match types of damp-proofing and drainage materials commonly used in construction to their correct descriptions.

- Discuss each of the damp-proofing/drainage materials listed in the objective. Give examples of where each material might be used in a commercial application. Use Figure 14 to illustrate your discussion.
- Bring in physical samples of as many damp-proofing/drainage materials as you can. Perform experiments with each material by subjecting each to flowing water (from a sink, garden hose, or any available water source). Have students discuss the results of the experiments.

SUGGESTED ACTIVITIES

Objective 13 Label common construction-material symbols used on architectural drawings.

- Refer back to the samples of the various building materials you have displayed for the students. Explain that the various material symbols used on architectural drawings are often derived from the actual characteristics of the building materials themselves. Then compare the symbols illustrated in this objective to the actual characteristics of the samples.
- Using the illustration in Teacher Supplement 1, "Sample Wall-Section Drawing," point out the various materials used in this drawing of a flat-roofed commercial building. Have students also note the structural shapes and material callouts.
- Discuss Assignment Sheet 2, "Practice Drawing Common Building-Material Symbols." Read the introduction and the directions and guidelines to the assignment. Answer any questions the students may have. Have students complete Assignment Sheet 2.

Evaluation

- Give written test.
- Compile written-test and assignment-sheet scores on Unit Evaluation Form.
- Reteach and retest as required.

Suggested Resources

Resources used in developing unit

- Allen, Edward. *Fundamentals of Building Construction—Materials and Methods.* New York: John Wiley and Sons, 1985.
- Biachina, Paul. *Illustrated Dictionary of Building Materials and Techniques.* Blue Ridge Summit, Pennsylvania: Tab Books, Inc., 1986.
- Lewis, Jack R. *Architectural Draftsmans Reference Handbook.* Englewood Cliffs, New Jersey: Prentice-Hall, 1982.
- Toenjes, Leonard P. *Building Trades Dictionary.* Homewood, Illinois: American Technical Publishers, 1989.
- Weidhaas, Ernest R. *Reading Architectural Plans for Residential and Commercial Construction.* Boston: Allyn-Bacon, Inc., 1977.

SUGGESTED ACTIVITIES

Additional resources

Media

- *Light Commercial Construction Series, Part 1—Planning—Structures and Their Designs.* Filmstrip. Career Aids, 20417 Nordhoff Street, Department ND 3, Chatsworth, California.

  Part 1 of a two-part program, this filmstrip explores the construction process as it relates to commercial buildings. An excellent introduction to commercial-construction practices, both filmstrips look at kinds of commercial structures and their designs, and also provide an introduction to building codes.

- *Modern Construction Technology.* Copyright 1988, VHS, 37 minutes. Career Aids, 20417 Nordhoff Street, Department ND 3, Chatsworth, California 91311.

  This video program examines construction practices, use of building materials, and design theories that are used to construct today's architectural wonders. The video provides an excellent overview to the ever-changing world of construction technology.

Computer software

- *Building Trade Series.* For Apple and compatible hardware, 48K, 1 disk, operating instructions, student checklist. Career Aids, 20417 Nordhoff Street, Department ND 3, Chatsworth California 91311.

  This software package provides questions on building-trades concepts and terminology. Areas covered include plans, drafting, masonry, foundations, excavation, concrete, special materials, and more.

ARCHITECTURAL BUILDING MATERIALS
UNIT 2

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

1. 18 inches
2. Pounds per foot of beam
3. 17 pounds
4. 8-inch channel depth
5. ⅜ inch
6. 6 inches and 4 inches

Assignment Sheet 2

Evaluated to the satisfaction of the instructor.

ARCHITECTURAL BUILDING MATERIALS
UNIT 2

ANSWERS TO WRITTEN TEST

1.

a.	12	m.	24
b	5	n.	15
c.	10	o.	13
d.	3	p.	14
e.	7	q.	18
f.	1	r.	19
g.	9	s.	22
h.	11	t.	21
i.	8	u.	20
j.	2	v.	16
k.	4	w.	17
l.	6	x.	23

2. Answer should include any 6 of the following

   a. Wood products
   b. Steel products
   c. Concrete products
   d. Construction masonry products
   e. Man-made materials
   f. Construction fasteners
   g. Glazing products
   h. Thermal-insulation materials
   i. Damp-proofing and drainage materials

3. a. Woods are classified as hard or soft, but that classification has more to do with the type of tree the lumber is made from than the actual hardness of the wood. Hardwood is produced from any of the groups of trees that have broad leaves. Softwood is produced from any of the needle- or cone-bearing trees.

   b. Lumber is graded based on its strength, appearance, number of defects, and other factors. Methods of grading are outlined by the American Lumber Standards Committee, and then detailed lists of grades and standards are developed by the various lumber producers' associations, such as the Southern Pine Inspection Bureau, California Redwood Association, Western Wood Products Association, and others. Hardwood grades are regulated by the National Hardwood Lumber Association.

   c. Lumber products come in standard sizes based on width, thickness, and length. Size may be *actual* or *nominal*. Nominal size is the size of the materials before final processing and tends to be larger than the actual size after drying and shaping.

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ANSWERS TO WRITTEN TEST

d. Most trees are sawed so that the growth rings form an angle of less than 45 degrees with the surface of the boards produced. Such lumber is called *flat-grained* in softwood or *plain-sawed* in hardwoods. Wood that is cut with the growth rings at an angle greater than 45 degrees is called *edge-grained* in softwoods and *quarter-sawed* in hardwoods.

4.	a.	1	e.	6
	b.	2	f.	4
	c.	3		
	d.	5		

5.	a.	3	f.	7
	b.	2	g.	9
	c.	1	h.	8
	d.	4	i.	5
	e.	6		

6. a. Powder made from alumina, silica, lime, iron oxide, and magnesia burned together in a kiln and finely pulverized; an ingredient in concrete

b. Building material made by mixing cement, sand and aggregates, admixtures, and water

7.	a.	1	g.	6
	b.	4	h.	8
	c.	3	i.	11
	d.	2	j.	10
	e.	5	k.	7
	f.	9		

8.	a.	5	d.	1
	b.	4	e.	6
	c.	3	f.	2

9.	a.	3	e.	7
	b.	2	f.	4
	c.	1	g.	6
	d.	8	h.	5

10. a. Insulating material usually composed of fiberglass, rock-wool, or cellulose material with or without a thin facing material, and made in relatively small units for convenience in handling and applying

b. Insulating material manufactured as small granules or particles that are poured or blown into voids in floors, walls, or roofs

ANSWERS TO WRITTEN TEST

c. Insulating material manufactured in stiff sheets designed to be nailed or glued to the surface to be insulated

11. a. 6
b. 2
c. 1
d. 5
e. 4
f. 3

12. a. 2
b. 3
c. 4
d. 1
e. 5
f. 8
g. 6
h. 7

13. a. Brick
b. Batt insulation
c. Concrete block
d. Concrete
e. Gravel
f. Earth
g. Reinforcing bars

ARCHITECTURAL BUILDING MATERIALS
UNIT 2

UNIT EVALUATION FORM

Student name Unit rating

Assignment sheet ratings

Assignment Sheet 1—Interpret Typical Designations for Common Structural-Steel Shapes Rating

Comments:

Assignment Sheet 2—Practice Drawing Common Building-Material Symbols Rating

Comments:

Written test scores

Pretest Other

Posttest

Instructor signature Date

Student signature Date

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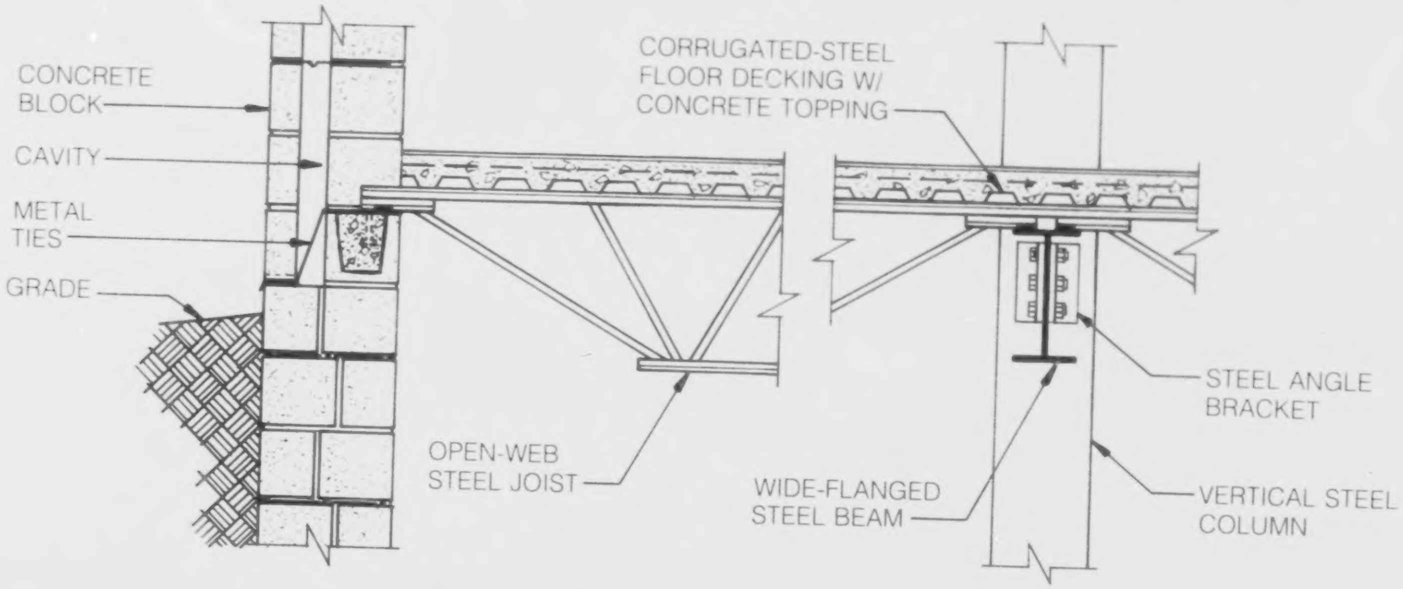
ARCHITECTURAL BUILDING MATERIALS
UNIT 2

TEACHER SUPPLEMENT 1—SAMPLE WALL-SECTION DRAWING

Shown below is a sample wall-section drawing for a commercial building. Note the use of material symbols and material callouts.


CONCRETE BLOCK
CAVITY
METAL TIES
GRADE
CORRUGATED-STEEL FLOOR DECKING W/ CONCRETE TOPPING
OPEN-WEB STEEL JOIST
WIDE-FLANGED STEEL BEAM
STEEL ANGLE BRACKET
VERTICAL STEEL COLUMN

Components of steel-and-masonry construction

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ARCHITECTURAL BUILDING MATERIALS
UNIT 2

TEACHER SUPPLEMENT 2—DIMENSION-LUMBER GRADES

Grade Selector Charts/All Species
Boards 1" (¾) and Thicker, Non-Stress-Rated
(Numbers in parentheses refer to WWPA grading-rules section numbers.)

APPEARANCE GRADES	**Selects**	B & Better	(IWP—Supreme)	(10.11)
		C Select	(IWP—Choice)	(10.12)
		D Select	(IWP—Quality)	(10.13)
	Finish	Superior	(10.51)	
		Prime	(10.52)	
		E	(10.53)	
	Paneling	Any Select or Finish grade or		
		Selected 2 Common for knotty paneling		(30.22)
		Selected 3 Common for knotty paneling		(30.23)
	Bevel or Bungalow Siding	Superior	(16.11)	
		Prime	(16.12)	
		(Refer to WWPA "Wood Siding" Catalog for other siding grades)		
GENERAL-PURPOSE BOARDS	**Common Boards (WWPA)**	1 Common	(IWP—Colonial)	(30.11)
		2 Common	(IWP—Sterling)	(30.12)
		3 Common	(IWP—Standard)	(30.13)
		4 Common	(IWP—Utility)	(30.14)
		5 Common	(IWP—Industrial)	(30.15)
	Alternate Boards (WCLIB)	Select Merchantable		(118-a)
		Construction		(118-b)
		Standard		(118-c)
		Utility		(118-d)
		Economy		(118-e)

Courtesy of Western Wood Products Association, Portland, Oregon.

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ARCHITECTURAL BUILDING MATERIALS
UNIT 2

TEACHER SUPPLEMENT 3—AMERICAN PLYWOOD ASSOCIATION VENEER GRADES

N	Smooth-surface "natural finish" veneer. Select, all heartwood or all sapwood. Free of open defects. Allows not more than 6 repairs, wood only per 4 × 8 panel, made parallel to grain and well matched for grain and color.
A	Smooth, paintable. Not more than 18 neatly made repairs, boat, sled, or router type, and parallel to grain, permitted. May be used for natural finish in less-demanding applications.
B	Solid surface. Shims, circular repair plugs and tight knots to 1 inch across grain permitted. Some minor splits permitted.
C Plugged	Improved C veneer with splits limited to ⅛-inch width and knotholes and borer holes limited to ¼ × ½ inch. Admits some broken grain. Synthetic repairs permitted.
C	Tight knots to 1½ inch. Knotholes to 1 inch across grain and some to 1½ inch if total width of knots and knotholes is within specified limits. Synthetic or wood repairs. Discoloration and sanding defects that do not impair strength permitted. Limited splits allowed. Stitching permitted.
D	Knots and knotholes to 2½ inch width across grain and ½ inch larger within specified limits. Limited splits are permitted. Stitching permitted. Limited to interior (exposure 1 or 2) panels.

Courtesy of American Plywood Association, Tacoma, Washington.

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ARCHITECTURAL BUILDING MATERIALS
UNIT 2

TEACHER SUPPLEMENT 4—INSULATION R-VALUES

Type of insulating material	R-value
Batt insulation	
Fiberglass (6-inch batt)	19.00
Rock-wool (5 to 5½-inch batt)	19.00
Loose-fill insulation	
Fiberglass	2.20 (per inch of thickness)
Rock-wool	2.90 (per inch of thickness)
Cellulose	3.75 (per inch of thickness)
Polystyrene	5.00 (per inch of thickness)

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ARCHITECTURAL BUILDING MATERIALS
UNIT 2

INFORMATION SHEET

1. **Terms and definitions associated with architectural building materials**

   a. **Admixture**—Agent added to concrete mix immediately before or during mixing to alter one or more characteristic of the concrete mix (i.e., speed of hardening, thickness of mix, etc.)

   b. **Aggregate**—Filler material used in concrete to provide volume at low cost

      NOTE: Aggregates make up about 60 to 80 percent of the volume of concrete. Sand, gravel, and crushed stone are the most commonly used aggregates.

   c. **Bentonite clay**—Highly absorptive and compressible clay material

   d. **Column**—Vertical structural member

   e. **Elevation drawing**—Vertical, two-dimensional view of each of the exterior faces of a building, showing general shape and design of exterior and roof

   f. **Fastener**—Mechanical device used to secure two or more members in position or to join two or more members

      EXAMPLES: Nails, screws, bolts

   g. **Foundation plan**—Plan view of entire substructure below first floor or frame of building

   h. **Gage**—Thickness of sheet metal

   i. **Groundwater**—Water near the surface of the earth; water absorbed through the subsoil

   j. **Joist**—Horizontal structural member used to support floor and ceiling loads in a building

   k. **Kiln**—Heated chamber used for firing brick and tile or drying timber

   l. **Laminated product**—Material created when two or more surfaces have been glued together to form a single unit

   m. **Lintel**—Horizontal structural member above a door or window opening; used to distribute the weight from the structure above to both sides of the opening

   n. **Load-bearing**—Supporting a load exerted from above

   o. **Lumber**—Any material, such as boards, planks, or beams, cut from timber to a size and form suitable for marketing

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INFORMATION SHEET

p. **Masonry**—Construction involving assembly of a structure using individual units such as brick, block, stone, or tile bonded with mortar

q. **Member**—Structural component; single component of a series or set

r. **Modular**—Fabricated based on a structural system that uses a 4-inch measurement for laying out the placement of structural members

s. **R-value**—Measure of the effectiveness of a material to provide thermal insulation

NOTE: Higher R-values indicate greater insulating capabilities.

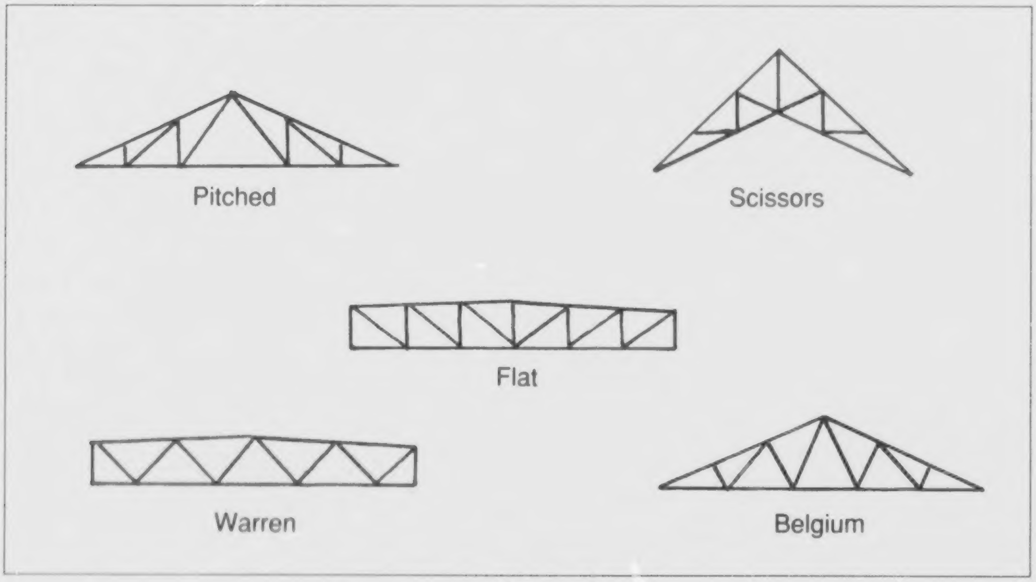
t. **Section drawing**—Cut-away view through an object or wall to show its interior makeup

u. **Surfacing**—Smoothing and truing the faces of a board

v. **Truss**—Structural member constructed of components commonly placed in a triangular arrangement

NOTE: Trusses (see Figure 1) are commonly used to support a roof.

FIGURE 1: Common roof trusses



w. **Veneer**—Thin layer of any building material used as a facing to cover a base layer (core) of another material

x. **Void**—Open area

INFORMATION SHEET

2. **Common types of architectural building materials**

   a. **Wood products**

   EXAMPLES: Lumber, plywood, glue-laminated timber

   NOTE: Wood is the material most used in construction because it is extremely strong yet light and easily shaped and worked. Wood is also readily recyclable and biodegradable, and it is our only renewable building material.

   b. **Steel products**

   EXAMPLES: Structural steel shapes, open-web steel joists, reinforcing bars, gage steel

   c. **Concrete products**

   d. **Construction masonry products**

   NOTE: Masonry products consist of bricks, stones, concrete blocks, and clay-tile products. In use for thousands of years (stone being the oldest natural building material and brick the oldest manufactured material), masonry products are used as building materials because of their durability, beauty, and endless selection of colors and textures.

   e. **Man-made materials**

   NOTE: Technological advances in engineering and manufacturing processes have permitted the development of a whole new range of building materials. These new materials include a wide range of plastics, laminates, and synthetics.

   f. **Construction fasteners**

   EXAMPLES: Nails, screws, bolts, welds

   g. **Glazing products**

   EXAMPLES: Tempered glass, laminated glass, wired glass, insulated glass, pattern glass, tinted glass, plastic

   h. **Thermal-insulation materials**

   NOTE: Insulating materials include any of a number of materials that are used in building construction (batt, loose-fill, rigid-sheet) to reduce heat loss and gain. Insulating materials are all assigned a heat-resistance value (R-value). The higher the R-value, the better the material is as a thermal insulator.

   i. **Damp-proofing and drainage materials**

   EXAMPLES: Damp-proofing materials—polyethylene sheeting, damp-proof coatings, bentonite clay, liquid water repellant; drainage materials—perforated drainpipe, drainage panel

INFORMATION SHEET

3. Characteristics of lumber used in construction

a. **Kind of wood**—Woods are classified as hard or soft, but that classification has more to do with the type of tree the lumber is made from than the actual hardness of the wood. Hardwood is produced from any of the groups of trees that have broad leaves. Softwood is produced from any of the needle- or cone-bearing trees.

b. **Grade**—Lumber is graded based on its strength, appearance, number of defects, and other factors. Methods of grading are outlined by the American Lumber Standards Committee, and then detailed lists of grades and standards are developed by the various lumber producers' associations, such as the Southern Pine Inspection Bureau, California Redwood Association, Western Wood Products Association, and others. Hardwood grades are regulated by the National Hardwood Lumber Association.

c. **Size**—Lumber products come in standard sizes based on width, thickness, and length. Size may be *actual* or *nominal.* Nominal size is the size of the materials before final processing and tends to be larger than the actual size after drying and shaping. (See Table 1.)

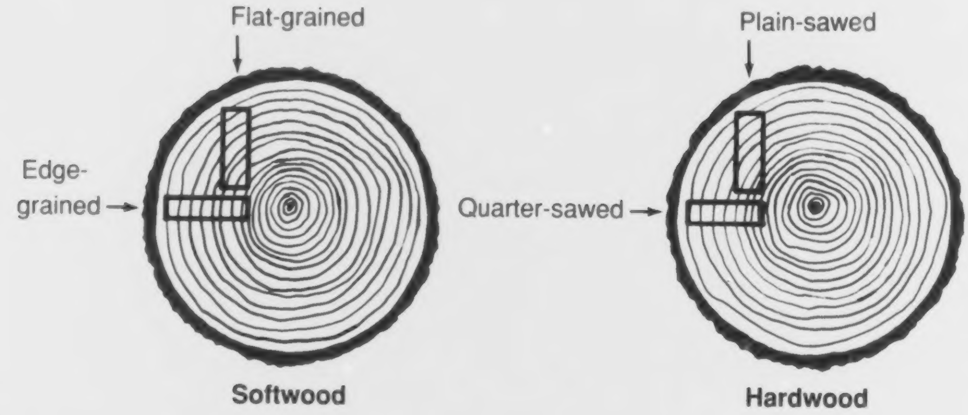
TABLE 1: Comparison of nominal and actual dimensions of common dimension lumber

Nominal dimension (in inches)	Actual dimension (in inches)
2 × 4	1½ × 3½
2 × 6	1½ × 5½
2 × 8	1½ × 7¼
2 × 10	1½ × 9¼
2 × 12	1½ × 11¼

d. **Sawing method**—Most trees are sawed so that the growth rings form an angle of less than 45 degrees with the surface of the boards produced. Such lumber is called *flat-grained* in softwood or *plain-sawed* in hardwoods. Wood that is cut with the growth rings at an angle greater than 45 degrees is called *edge-grained* in softwoods and *quarter-sawed* in hardwoods. (See Figure 2.)

INFORMATION SHEET

FIGURE 2: Sawing methods



4. Types of wood products commonly used in construction and their definitions

a. **Dimension lumber**—Solid-wood members 2 to 5 inches thick and 2 inches or more wide

(1) **Rough framing members**—Nonsurfaced dimension lumber used as structural and backing supports

NOTE: Rough framing members are lumber with uneven, unfinished surfaces that are later covered by finish materials.

(2) **Finished wood trim**—Surfaced dimension lumber that is left exposed at completion of construction

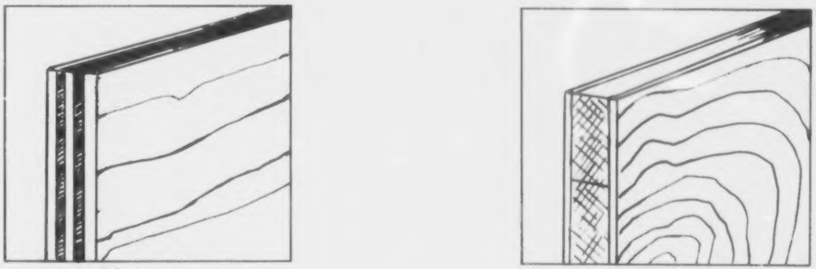
NOTE: Finish material, such as that applied around window and door openings or at the floor and ceilings of rooms, requires a high grade of lumber for a desirable appearance.

b. **Plywood panels** (see Figure 3)—Fabricated wood products manufactured from an odd number of wood sheets joined with glue

NOTE: Standard plywood-sheet size is 4′-0″ wide and 8′-0″ long. Different thicknesses, core materials, and surface thicknesses are available.

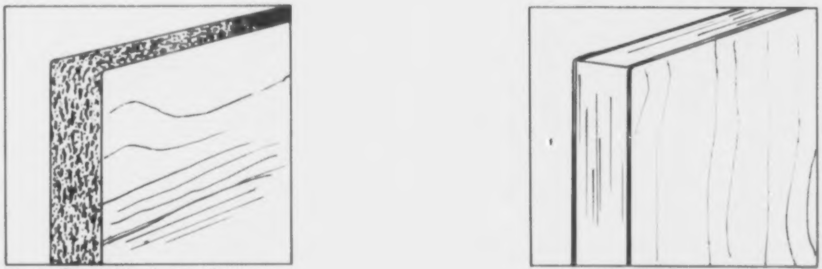
INFORMATION SHEET

FIGURE 3: Types of plywood core construction



(a) Veneer core

(b) Lumber core



(c) Particle-board core

(d) Fiberboard core

c. **Heavy timbers**—Square-sawn wood members 5 inches or more thick and 5 inches or more wide

NOTE: Large timber members are defined normally in relation to the span (in feet) that they support. For example, a timber beam will have an actual depth of approximately one-sixteenth of its span. Heavy timbers have certain advantages over steel or masonry in that they can be cut to nominal dimensions, retain their structural integrity much longer during fire, and also are more appealing in appearance and finish.

d. **Glue-laminated timbers**—Timbers created when two or more strips of wood are glued together to form a single wood member

NOTE: Glue-laminated timbers can provide extensive structural support for construction.

INFORMATION SHEET

5. **Types of steel products commonly used in construction and their descriptions**

    a. **Structural steel shapes** (Figure 4)—Steel products produced in standard shapes (beams, angles, etc.) and sizes so that architects and engineers will be able to select members for construction that will result in good connections and a minimal waste of steel

    (1) **American standard beams**—I-shaped steel members used as both load-carrying horizontal beams and load-carrying vertical columns

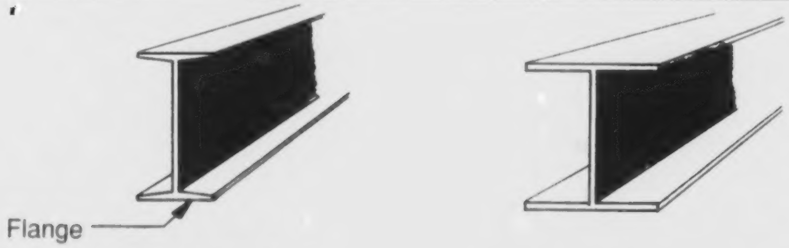
    (2) **Wide-flanged beams**—H-shaped steel members with wider flanges than American standard beams; used primarily for horizontal beams and vertical columns

    NOTE: The wider flanges of this type of beam increase the load-carrying capacity of the beam.

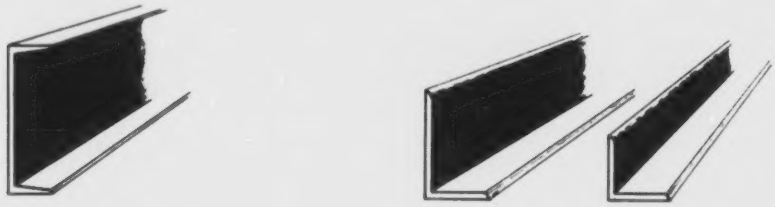
    (3) **Channel steel**—C-shaped steel members used for bracing, short beams, and lintels

    (4) **Steel angles**—L-shaped members produced with equal or unequal legs and used as short beams, window and door lintels, diagonal braces, and as connecting members for wide-flanged beams

FIGURE 4: Structural-steel shapes



(a) **American standard** (b) **Wide-flanged**



(c) **Channel steel** (d) **Steel angles**

INFORMATION SHEET

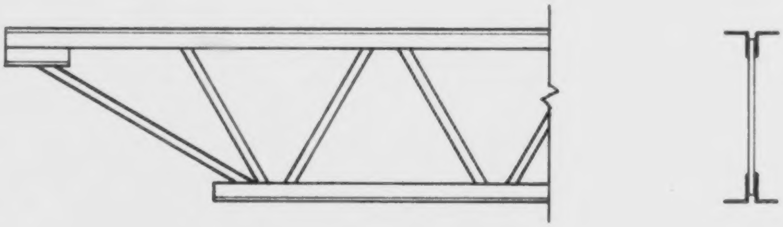
b. **Open-web joists** (Figure 5)—Mass-produced structural-steel joists (trusses) formed from steel angles and steel rods and used in equally spaced arrays to provide support for floor loads and roof loads

NOTE: Joists are classified according to the joist depth and the span the joist will carry. Table 2 below shows common joist designations, depths, and spans.

TABLE 2

Joist designation	Depth (in inches)	Span (in feet)
J or H	8 to 24	8 to 48
LJ or LH	18 to 48	25 to 96
DLJ or DLH	52 to 72	89 to 144

FIGURE 5



(a) Elevation view of end of open-web steel joist

(b) Section view showing double-angle top and bottom chords with steel-rod diagonal chords welded between

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c. **Reinforcing bars** (rebar)—Steel rods produced in various diameters and designed to be embedded in concrete to provide strength in tension

d. **Gage steel**—Thin sheets of steel formed into various shapes and used as rigid structural members

NOTE: Gage steels are fabricated as wall studs, window and door frames, roof decking, and mechanical ductwork.

INFORMATION SHEET

e. **Welded wire fabric**—Square grids formed of wire fabric and used to provide tension strength when embedded in concrete-slab floors

6. Definitions of the terms *cement* and *concrete*

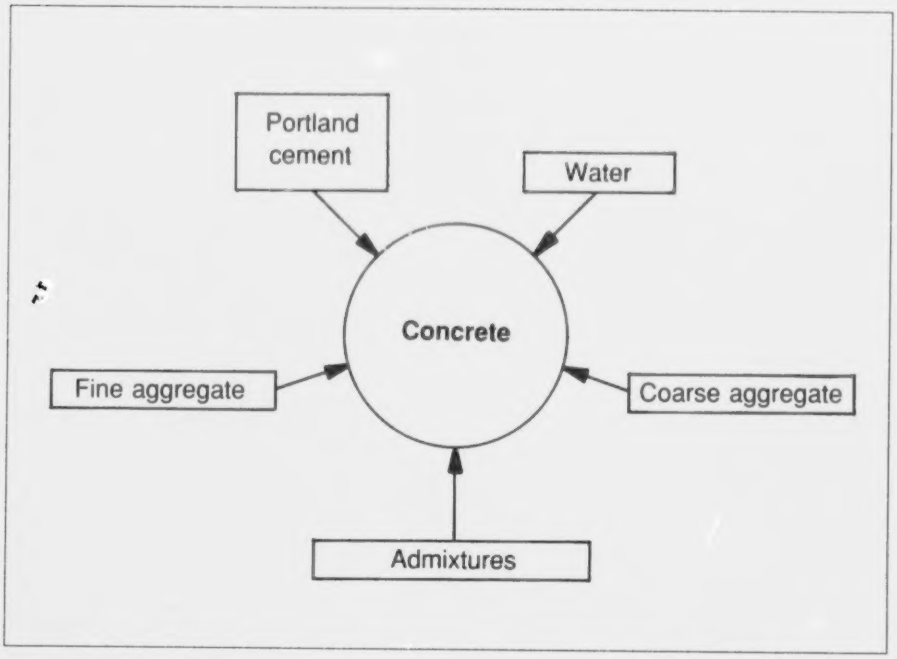
a. **Cement**—Powder made from alumina, silica, lime, iron oxide, and magnesia burned together in a kiln and finely pulverized; an ingredient in concrete

NOTE: During the cement manufacturing process, two types of raw materials—one made primarily from limestone, marl, and shells and another made primarily from clay, shale, silica sand, iron ore, and alumina—are blended, ground, and dried; then clinker and gypsum are added and that mixture is ground again. After the manufacturing process is complete, cement is ground so finely that it will pass through a #200 sieve, which has 40,000 openings per square inch.

b. **Concrete**—Building material made by mixing cement, sand and aggregates, admixtures, and water

NOTE: The elements listed above are mixed in various ratios depending upon the required strength and application. See Figure 6. The concrete is then allowed to set (cure) for approximately 28 days until it reaches nearly full strength.

FIGURE 6: Basic elements of concrete



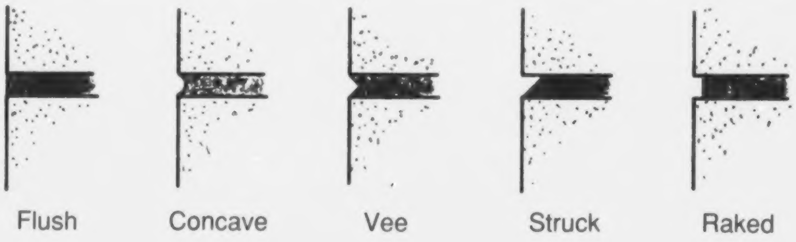
INFORMATION SHEET

7. **Types of masonry products commonly used in construction and their definitions**

   a. **Mortar**—Mixture of fine aggregate and cement paste used to fill voids between aggregate or masonry units and reinforce the structure

   NOTE: Mortar provides cushioning, acts to seal the units from wind and water, and adheres the units to one another to bond them into a single structural unit. The typical mortar joints are shown in Figure 7 below.

   FIGURE 7: Typical mortar joints

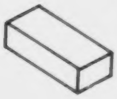


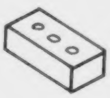
   b. **Brick**—Rectangular blocks made from clay or clay mixture molded into blocks and then hardened by drying in the sun or baking in a kiln

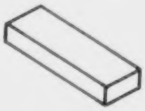
   NOTE: Brick has two distinct qualities: size and resistance to fire. Its small unit size (see Table 3) permits great variation in appearance and design, and brick is the most fire-resistant masonry product available.

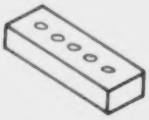
TABLE 3: Brick sizes

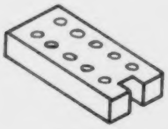
	Actual dimensions			Modular dimensions		
	Width	Height	Length	Width	Height	Length
Standard	3¾″	2¼″	8″			
Modular	3½″	2⅙″	7½″	4″	2⅔″	8″
Roman	3½″	1½″	11½″	4″	2″	12″
Norman	3½″	2⅙″	11½″	4″	2⅔″	12″
SCR	5½″	2⅙″	11½″	6″	2⅔″	12″


Standard


Modular


Roman


Norman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(1) **Face brick** (facing brick)—Brick finish product manufactured under strictly controlled standards for dimension, color, and structural quality

(2) **Common brick**—Brick product manufactured under less strictly controlled standards for dimension and color and used for wall backing or other applications where appearance is not important

c. **Stone masonry**—Masonry product formed of natural rock

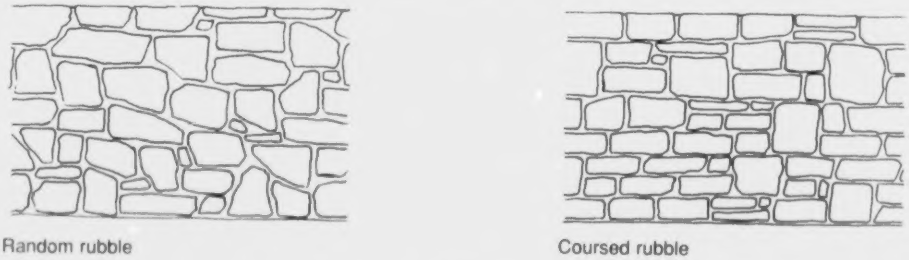
NOTE: Used primarily for its decorative appearance, stone masonry can be laid like brick, using mortar, or attached with fasteners in large thin sheets as a facing over a structural frame.

(1) **Rubblestone** (rubble, rubble masonry)—Stone-masonry product composed of roughly squared stone with irregular size and shape (see Figure 8-a)

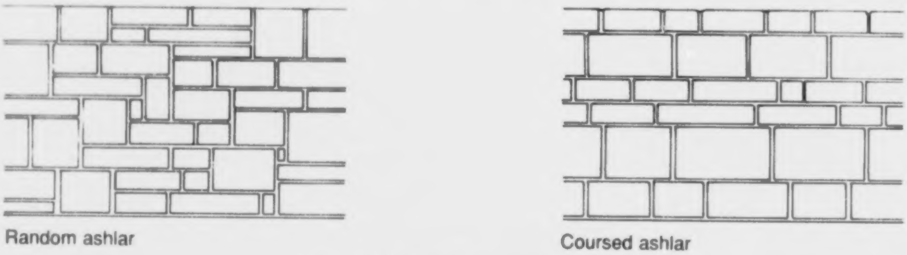
NOTE: Rubblestone construction is composed of irregularly shaped pieces that must be matched to all other pieces for a good fit and is used where a rustic appearance is desired.

(2) **Cut stone** (ashlar)—Stone-masonry product composed of squared stone with a flat surface (see Figure 8-b)

FIGURE 8: Stone-masonry products



(a) **Rubblestone**



(b) **Cut stone (ashlar)**

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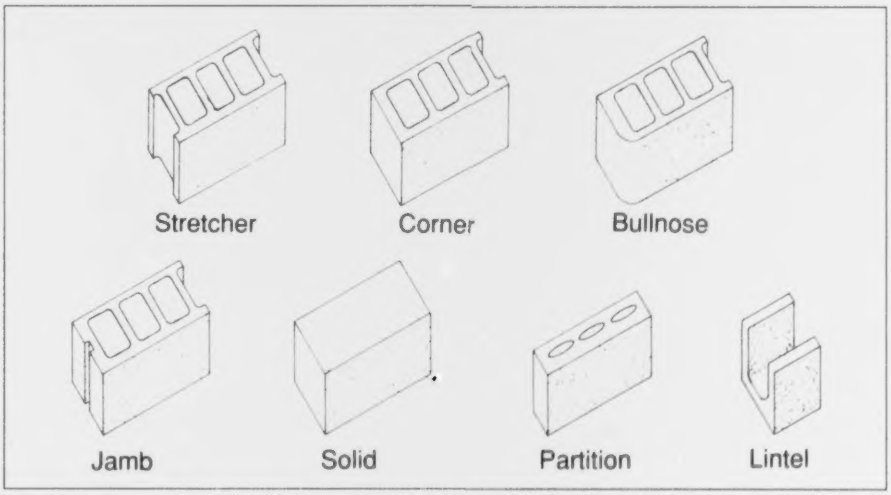
d. **Concrete block** (Figure 9)—Concrete masonry units (CMUs) formed into modular sizes and shapes and used in constructing load-bearing walls, foundation walls, non-load-bearing partitions, and as a backup for other walls

FIGURE 9: Common CMUs



e. **Clay-tile product**—Fired-clay product used for roofing, drainage pipe, and wall and floor finish material

   (1) **Structural clay tile**—Hollow or solid building members molded from clay, set in mortar, and used in masonry construction such as non-load-bearing partition walls, backup for walls, and as fireproofing around structural steel

   (2) **Tile**—Fired-clay product used as finish material for floors, walls, or roofs

   NOTE: Tile is set in place using cement, latex adhesive, or epoxy mortar.

8. Types of fasteners commonly used in construction and their descriptions

a. **Nails**—Fasteners consisting of a straight, slender piece of metal with one pointed end and one end that is struck with hammer or driven with pneumatic or powder-actuated gun

NOTE: Nails come in various sizes, finishes, and materials for use in different applications (i.e., roofing, masonry, wood). See Figure 10. Common nails and finish nails are the two most common types used.

   (1) **Common nails**—Nails with a smooth cylindrical shaft and a flat head

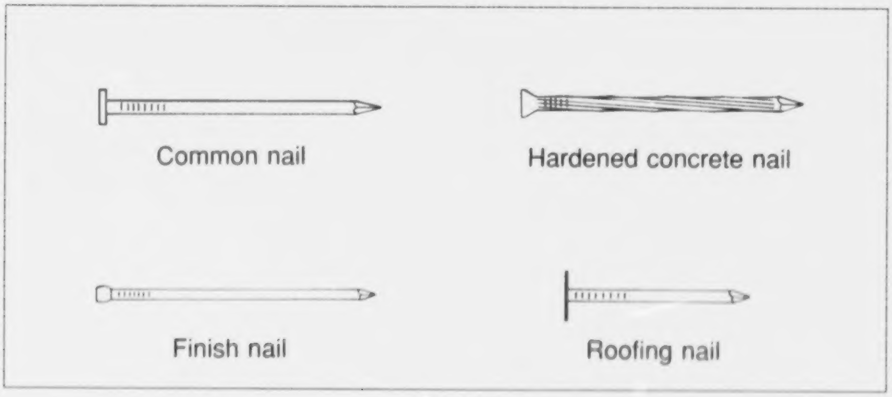
   NOTE: Common nails are used for light-frame wood construction, roofing, and masonry.

INFORMATION SHEET

(2) **Finish nails**—Nails with a smooth shaft and a very small barrel-shaped head that creates a small void in the surface of the workpiece

NOTE: Finish nails are used for finished woodwork such as cabinetry and other areas where appearance is important.

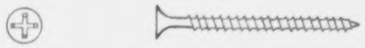
FIGURE 10: Common types of nails



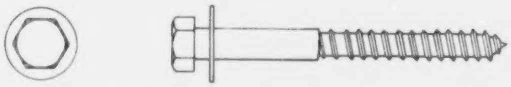
b. **Screws**—Wood or metal fasteners consisting of a tapered, threaded shank and a head designed to allow turning of the fastener

NOTE: Screws are used where it may be necessary to remove a fastener at a later date for adjustment or remounting. Screws are manufactured with various types of threading depending upon the type of material the screw is to be used with (i.e., wood, metal, sheet metal). See Figure 11. Screws form stronger connections than nails.

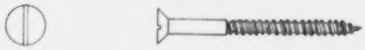
FIGURE 11: Common types of screws



(a) Drywall screw with Phillips head



(b) Lag screw with hex head



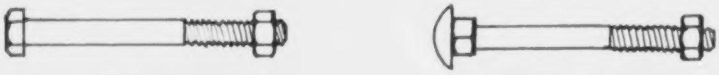
(c) Wood screw with slotted head

INFORMATION SHEET

c. **Bolts** (Figure 12)—Large cylindrical fasteners usually consisting of a piece of metal having a head or hooked end and a fully or partially threaded body

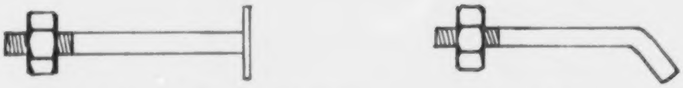
NOTE: Bolts are used for heavier structural applications and have nuts that are threaded opposite the head end to secure the connection and prevent the bolt from loosening or backing out.

FIGURE 12: Common types of bolts used in building construction



(a) Machine bolt

(b) Carriage bolt



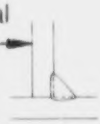
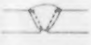
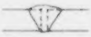
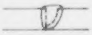
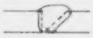
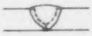
(c) Anchor bolt with welded plate

(d) J-bolt

d. **Welds**—Method of using high electrical voltage to create intense heat that then bonds a steel welding rod to structural members to be joined

NOTE: The welding process creates a structural connection that is actually stronger than the members themselves. Figure 13 shows common types of welds and their appropriate drawing symbols.

FIGURE 13: Common welds

<table>
<tr><th>Weld Symbol</th><th>Weld Type</th><th>Weld Symbol</th><th>Weld Type</th></tr>
<tr><td>◺</td><td>Structural member

Fillet weld</td><td>∨</td><td>
V-weld</td></tr>
<tr><td>||</td><td>
Square weld</td><td>|)</td><td>
J-weld</td></tr>
<tr><td>|/</td><td>
Bevel weld</td><td>∪</td><td>
U-weld</td></tr>
</table>

INFORMATION SHEET

9. **Types of glazing products commonly used in construction and their descriptions**

   a. **Sheet glass** (window glass)—Clear or opaque glass material manufactured in continuous, long flat pieces and cut to desired sizes and shapes

      NOTE: Sheet glass is manufactured in single strength (3/32" to 1/8") and double strength (1/8" to 7/8"). It is used primarily in low buildings with relatively small windows.

   b. **Tempered glass**—Glass manufactured by reheating and then rapidly cooling cut glass, resulting in a glass that is much more resistant to thermal stress and impact

      NOTE: Tempered glass is used for windows exposed to heavy wind pressures or to intense heat and cold and for doors and windows next to doors.

   c. **Laminated glass**—Glass manufactured by bonding transparent vinyl between layers of sheet glass, resulting in a safety glass that adheres to the vinyl if broken

      NOTE: Laminated glass is used in public areas, overhead, and in large exposed facilities, providing a large degree of safety to people.

   d. **Wired glass** (wire glass)—Glass in which wire mesh is embedded between two layers of sheet glass, resulting in a safety glass that prevents the glass from shattering if broken

      NOTE: Wired glass is used for windows in fire doors and fire walls because it maintains its integrity as a fire barrier much longer than any other glass product.

   e. **Insulated glass**—Glass manufactured by separating layers of sheet glass with a 1/8- to 1-inch air space that is then sealed

      NOTE: Insulated glass is used in buildings where insulation factors are important.

   f. **Pattern glass**—Glass produced with different surface designs that obscure vision but allow light transmission

      NOTE: Pattern glass is used where privacy is an important factor.

   g. **Tinted glass**—Colored glass produced by adding small amounts of chemical elements to the molten glass mixture

      NOTE: Tinted glass is used in windows to achieve a desired appearance as well as to control light and heat transmission into a building's interior.

INFORMATION SHEET

h. **Plastic**—Glazing product manufactured from clear or opaque synthetic materials

NOTE: Plastics are in common use today to help control the costs of glazing materials and to provide an added measure of safety.

10. **Types of thermal-insulation materials commonly used in construction and their descriptions**

a. **Batt insulation** (blanket insulation)—Insulating material usually composed of fiberglass, rock-wool, or cellulose material with or without a thin facing material, and made in relatively small units for convenience in handling and applying

NOTE: Sizes of batt insulation vary from 3 to 7 inches or more in thickness, 15 to 23 inches in width, and they are usually 48 inches in length. Facing materials may be kraft paper, metal foil, or plastic sheets.

b. **Loose-fill insulation**—Insulating material manufactured as small granules or particles that are poured or blown into voids in floors, walls, or roofs

NOTE: Some of the more-common materials used in loose-fill insulation are cellulose, perlite, fiberglass, and vermiculite.

c. **Rigid-sheet insulation**—Insulating material manufactured in stiff sheets designed to be nailed or glued to the surface to be insulated

NOTE: Rigid-sheet insulation is produced in 2′ × 8′ or 4′ × 8′ sizes, comes in varying thicknesses, and is usually made from polystyrene or urethane-foam materials.

11. **Thermal-insulation applications and their descriptions**

NOTE: Applications for thermal insulation are commonly described by the area in the building where the insulation will be located (i.e., floor, wall).

a. **Ceiling insulation**—Batt or loose-fill insulation placed above the ceiling framing to provide resistance to heat conduction into the area above the ceiling

b. **Floor insulation**—Batt or rigid-sheet insulation placed below the floor framing to provide resistance to heat conduction into the crawl-space area

c. **Perimeter insulation**—Batt or rigid-sheet insulation installed over a building's concrete foundation wall

d. **Wall insulation**—Any of the various types of thermal insulation placed between structural wall members to provide resistance to heat conduction in and out of the building

e. **Duct insulation**—Insulation wrapped around heating and cooling ductwork to reduce heat or cooling loss from the ducts

f. **Slab insulation**—Rigid-sheet insulation placed below a concrete slab to provide resistance to heat conduction from the concrete slab

INFORMATION SHEET

12. **Types of damp-proofing and drainage materials commonly used in construction and their descriptions**

NOTE: The portion of a building below the ground (finished grade line) is subject to groundwater penetration. The two fundamental ways to address this major problem are through the proper use of damp-proofing materials and drainage systems.

a. **Damp-proofing materials**—Materials that prevent the flow of groundwater into structural members

(1) **Polyethylene sheeting**—Flexible plastic sheets placed between concrete-slab floors and grade to act as a vapor barrier to prevent groundwater from penetrating upward into slab floor

(2) **Damp-proof coatings**—Asphalt-based liquid brushed or sprayed onto foundation walls to seal concrete and prevent groundwater penetration into foundation

(3) **Bentonite-clay sheets**—Corrugated cardboard sheets with internal cells filled with dry bentonite clay; when applied to foundation walls and then saturated with water, the sheets expand and form a continuous nonporous membrane over foundation walls

(4) **Water repellant**—Liquid brushed on wood and other porous materials to prevent water penetration

b. **Drainage-system materials**—Pipes and panels used with channels or trenches to convey groundwater away from structure

NOTE: Drainage materials are extremely important in preventing groundwater buildup (hydrostatic pressure) against foundation walls and concrete floor slabs. See Figure 14.

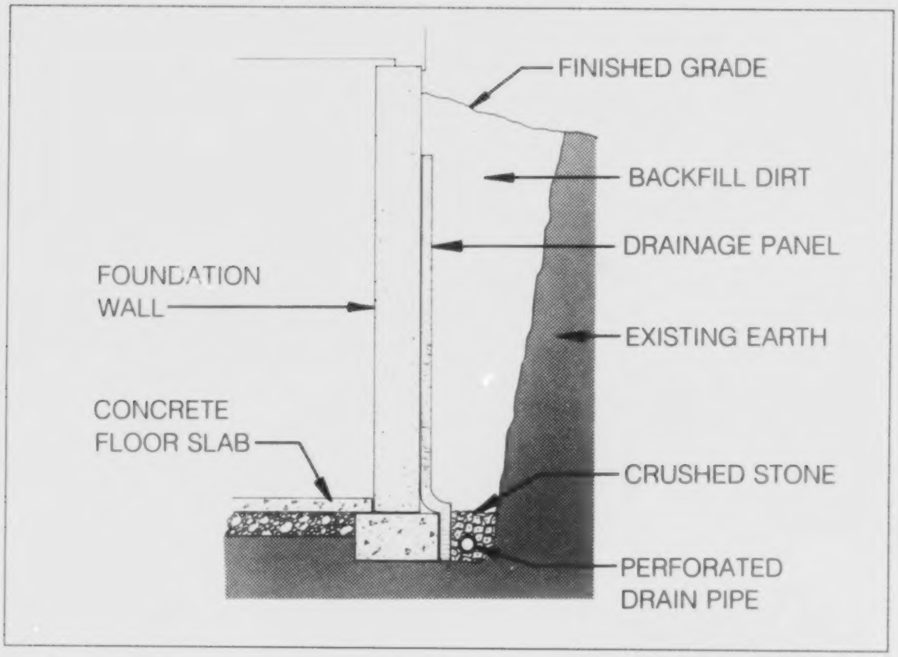
(1) **Perforated drain pipe**—Pipe with a series of holes; pipe is placed outside foundation walls at footing to channel groundwater away from structure by gravity

(2) **Drainage panel**—Panel constructed of an open porous material with a fabric filter exterior; when panel is attached to foundation walls, fabric filter allows groundwater to enter panel, where it is channelled downward and emptied into drainage pipe

NOTE: In some areas of the country, drainage fill will be used in place of a drainage panel.

INFORMATION SHEET

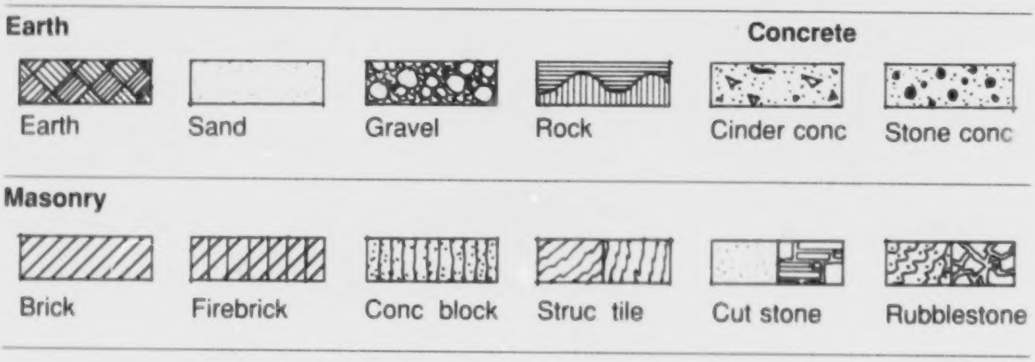
FIGURE 14


FINISHED GRADE
BACKFILL DIRT
DRAINAGE PANEL
FOUNDATION WALL
EXISTING EARTH
CONCRETE FLOOR SLAB
CRUSHED STONE
PERFORATED DRAIN PIPE

13. **Common construction-material symbols used on architectural drawings** (Table 4)

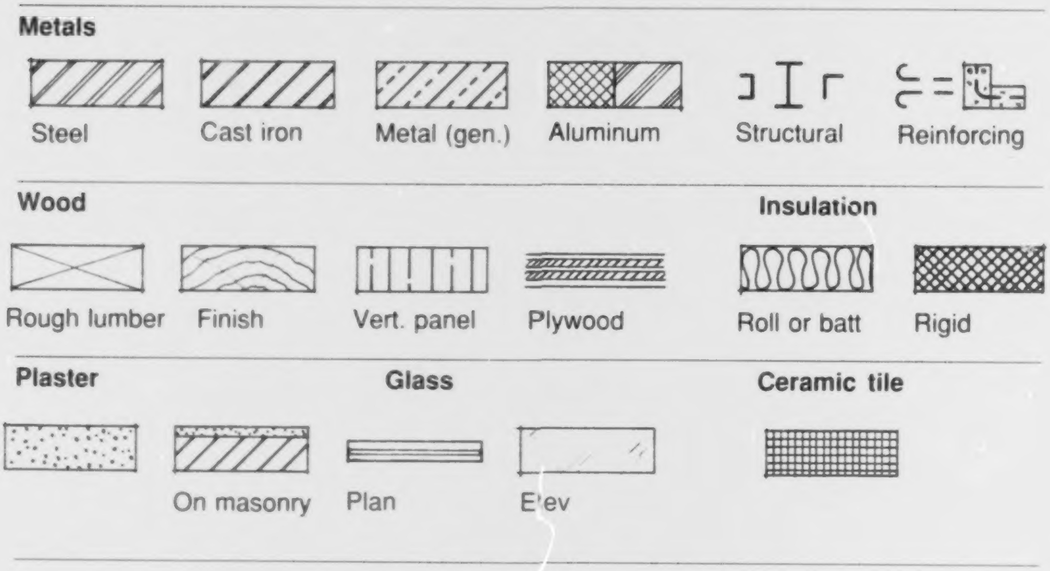
NOTE: The symbols shown below are those used on section drawings. Symbols are often modified on other types of drawings, such as foundation plans and elevation drawings. Also, the symbols shown are for the materials most commonly used as architectural building materials. Consult *Architectural Graphic Standards* for any symbols not shown on the table below.

TABLE 4: Common construction-material symbols


Earth
Concrete
Earth
Sand
Gravel
Rock
Cinder conc
Stone conc
Masonry
Brick
Firebrick
Conc block
Struc tile
Cut stone
Rubblestone

INFORMATION SHEET

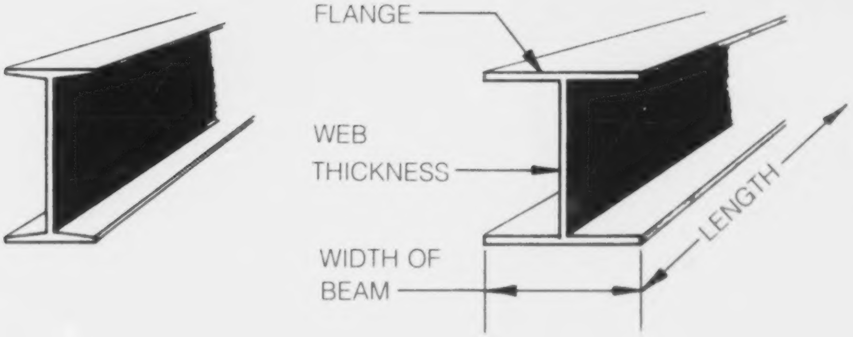
TABLE 4 (cont.)


Metals
Steel
Cast iron
Metal (gen.)
Aluminum
Structural
Reinforcing
Wood
Rough lumber
Finish
Vert. panel
Plywood
Insulation
Roll or batt
Rigid
Plaster
On masonry
Glass
Plan
Elev
Ceramic tile

ARCHITECTURAL BUILDING MATERIALS
UNIT 2

STUDENT SUPPLEMENT 1—TYPICAL DESIGNATIONS FOR STRUCTURAL-STEEL SHAPES

Descriptive name	Typical designation	Explanation
American standard beam	S8×23	*S* is the symbol identifying an American Standard beam. *8* is the nominal beam depth in inches. *23* is the weight per foot of length in pounds.
Wide-flanged beam	W21×142	*W* is the symbol identifying a wide-flanged beam. *21* is the nominal beam depth in inches. *142* is the weight per foot of length in pounds.
Channel steel	C6×13	*C* is the symbol identifying channel steel. *6* is the nominal depth in inches. *13* is the weight per foot of length in pounds.
Steel angle—unequal legs	L8×6×½"	*L* is the symbol identifying steel angle. *8* is the length of the long leg in inches. *6* is the length of the short leg in inches. *½* is the material thickness of the angle in inches.



ARCHITECTURAL BUILDING MATERIALS
UNIT 2

ASSIGNMENT SHEET 1—INTERPRET TYPICAL DESIGNATIONS FOR COMMON STRUCTURAL-STEEL SHAPES

Name ______________________________ Score ______________

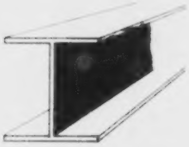
Introduction

Assignment Sheet 1 provides a drafter with a fundamental knowledge of the common "language" used by professionals in the engineering, construction, and architectural disciplines to describe structural steel.

Exercise

Directions

Study the information in Student Supplement 1, "Typical Designations for Structural-Steel Shapes," and then answer the questions below as they pertain to the structural-steel shapes illustrated in Figures 1 through 3. Write your answers on the blanks provided.



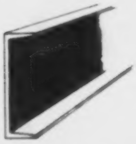
W-shape beam
W 18 × 112
FIGURE 1

1. On the wide-flanged beam shown in Figure 1, what is the vertical dimension (beam depth) in inches?

   Vertical dimension ______________________________

2. What does the *112* callout denote in the W18×112 description of the wide-flanged beam shown in Figure 1?

   ____



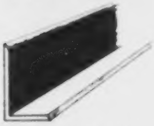
Channel steel
C 8 × 17
FIGURE 2

3. On the piece of channel steel shown in Figure 2, what is the weight per foot of steel in pounds?

   Weight ______________________________

4. What does the callout *8* denote in the C8×17 description of the channel steel shown in Figure 2?

   ____



Unequal-leg
steel angle
L 6 × 4 × ⅜″
FIGURE 3

5. What is the material thickness of the steel angle shown in Figure 3?

   Thickness ______________________________

6. What are the lengths in inches of the two legs of the steel angle shown in Figure 3?

   Lengths ______________________________

ARCHITECTURAL BUILDING MATERIALS
UNIT 2

ASSIGNMENT SHEET 2—PRACTICE DRAWING COMMON BUILDING-MATERIAL SYMBOLS

Name ______________________________ Score ______________

Introduction Assignment Sheet 2 provides a drafter with a basic understanding of the material symbols used most often in developing architectural working drawings and their correct drawing construction.

Exercise

Directions Using the guidelines given below and the proper architectural-materials symbols, draw on the following page a to-scale wall-section drawing similar to the sketch shown in Figure 1 below.

Guidelines

Scale: ¾" = 1'-0"

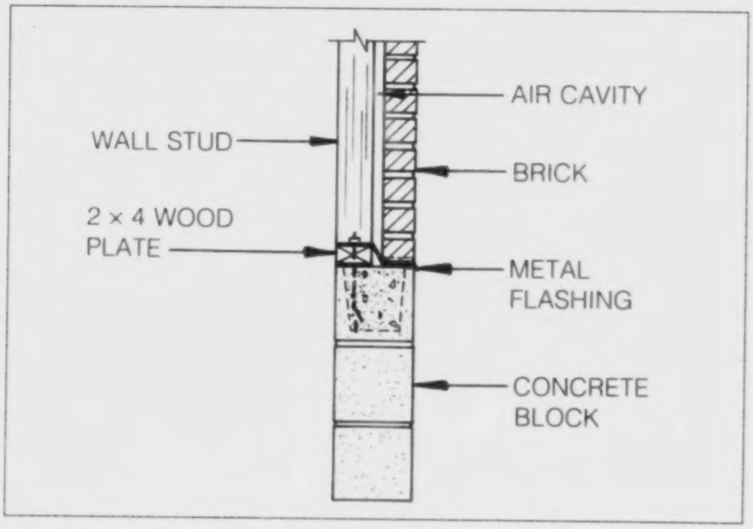
Wood: Nominal 2" × 4" stud

Brick: Modular size

Concrete block: 8" × 8" × 16"

Air cavity: 1" between 2" × 4" wall stud and modular brick

FIGURE 1



ASSIGNMENT SHEET 2

Scaled drawing

ARCHITECTURAL BUILDING MATERIALS
UNIT 2

WRITTEN TEST

Name ______________________________ Score ______________

1. Match terms associated with architectural building materials to their correct definitions. Write the numbers on the blanks provided. Terms and definitions continue on the next page.

______a. Horizontal structural member above a door or window opening; used to distribute the weight from the structure above to both sides of the opening

______b. Mechanical device used to secure two or more members in position or to join two or more members

______c. Heated chamber used for firing brick and tile or drying timber

______d. Highly absorptive and compressible clay material

______e. Thickness of sheet metal

______f. Agent added to concrete mix immediately before or during mixing to alter one or more characteristic of the concrete mix

______g. Horizontal structural member used to support floor and ceiling loads in a building

______h. Material created when two or more surfaces have been glued together to form a single unit

______i. Structural component; single component of a series or set

______j. Filler material used in concrete to provide volume at low cost

______k. Vertical, two-dimensional view of each of the exterior faces of a building, showing general shape and design of exterior and roof

______l. Plan view of entire substructure below first floor or frame of building

1. Admixture
2. Aggregate
3. Bentonite clay
4. Elevation drawing
5. Fastener
6. Foundation plan
7. Gage
8. Member
9. Joist
10. Kiln
11. Laminated product
12. Lintel

WRITTEN TEST

_______m. Vertical structural member

_______n. Water near the surface of the earth; water absorbed through the subsoil

_______o. Supporting a load exerted from above

_______p. Open area

_______q. Cut-away view through an object or wall to show its interior makeup

_______r. Any material, such as boards, planks, or beams, cut from timber to a size and form suitable for marketing

_______s. Fabricated based on a structural system that uses a 4-inch measurement for laying out the placement of structural members

_______t. Smoothing and truing the faces of a board

_______u. Thin layer of any building material used as a facing to cover a base layer of another material

_______v. Construction involving assembly of a structure using individual units such as brick, block, stone, or tile bonded with mortar

_______w. Structural member constructed of components commonly placed in a triangular arrangement

_______x. Measure of the effectiveness of a material to provide thermal insulation

13. Load-bearing
14. Void
15. Groundwater
16. Masonry
17. Truss
18. Section drawing
19. Lumber
20. Veneer
21. Surfacing
22. Modular
23. R-value
24. Column

2. List six common types of architectural building materials. Write your answers on the blanks provided.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

WRITTEN TEST

3. Discuss the characteristics of lumber used in construction. Write your answers on the blanks provided beside each characteristic below.

   a. Kind of wood ____________________

   b. Grade ____________________

   c. Size ____________________

   d. Sawing method ____________________

WRITTEN TEST

4. Match types of wood products commonly used in construction to their correct definitions. Write the numbers on the blanks provided.

_______a. Surfaced dimension lumber that is left exposed at completion of construction

_______b. Square-sawn wood members 5 inches or more thick and 5 inches or more wide

_______c. Solid-wood members 2 to 5 inches thick and 2 inches or more wide

_______d. Fabricated wood products manufactured from an odd number of wood sheets joined with glue

_______e. Timbers created when two or more strips of wood are glued together to form a single wood member

_______f. Nonsurfaced dimension lumber used as structural and backing supports

1. Finished wood trim
2. Heavy timbers
3. Dimension lumber
4. Rough framing members
5. Plywood panels
6. Glue-laminated timbers

5. Match types of steel products commonly used in construction to their correct descriptions. Write the numbers on the blanks provided. Products and descriptions continue on the next page.

_______a. Thin sheets of steel formed into various shapes and used as rigid structural members

_______b. I-shaped steel members used as both load-carrying horizontal beams and load-carrying vertical columns

_______c. L-shaped members produced with equal or unequal legs and used as short beams, window and door lintels, diagonal braces, and as connecting members for wide-flanged beams

_______d. Square grids formed of wire fabric and used to provide tension strength when embedded in concrete-slab floors

1. Steel angles
2. American standard beams
3. Gage steel
4. Welded wire fabric

WRITTEN TEST

______ e. Steel products produced in standard shapes and sizes so that architects and engineers will be able to select members for construction that will result in good connections and a minimal waste of steel

______ f. Mass-produced structural-steel joists formed from steel angles and steel rods and used in equally spaced arrays to provide support for floor loads and roof loads

______ g. H-shaped steel members with wider flanges than American standard beams; used primarily for horizontal beams and vertical columns

______ h. Steel rods produced in various diameters and designed to be embedded in concrete to provide strength in tension

______ i. C-shaped steel members used for bracing, short beams, and lintels

5. Channel steel
6. Structural steel shapes
7. Open-web joists
8. Reinforcing bars
9. Wide-flanged beams

6. Define the terms *cement* and *concrete*. Write your answers on the blanks provided beside each term below.

a. Cement ____

____

____

____

____

b. Concrete ______________________________________

____

____

____

____

WRITTEN TEST

7. Match types of masonry products commonly used in construction to their correct definitions. Write the numbers on the blanks provided.

_______a. Mixture of fine aggregate and cement paste used to fill voids between aggregate or masonry units and reinforce the structure

_______b. Fired-clay product used for roofing, drainage pipe, and wall and floor finish material

_______c. Concrete-masonry units formed into modular sizes and shapes and used in constructing load-bearing walls, foundation walls, non-load-bearing partitions, and as a backup for other walls

_______d. Masonry product formed of natural rock

_______e. Rectangular blocks made from clay or clay mixture molded into blocks and then hardened by drying in the sun or baking in a kiln

_______f. Brick product manufactured under less strictly controlled standards for dimension and color and used for wall backing or other applications where appearance is not important

_______g. Hollow or solid building members molded from clay, set in mortar, and used in masonry construction such as non-load-bearing partition walls, backup for walls, and as fireproofing around structural steel

_______h. Stone-masonry product composed of squared stone with a flat surface

_______i. Fired-clay product used as finish material for floors, walls, or roofs

_______j. Stone-masonry product composed of roughly squared stone with irregular size and shape

_______k. Brick finish product manufactured under strictly controlled standards for dimension, color, and structural quality

1. Mortar
2. Stone masonry
3. Concrete block
4. Clay-tile product
5. Brick
6. Structural clay tile
7. Face brick
8. Cut stone
9. Common brick
10. Rubblestone
11. Tile

WRITTEN TEST

8. Match types of fasteners commonly used in construction to their correct descriptions. Write the numbers on the blanks provided.

_______a. Large cylindrical fasteners usually consisting of a piece of metal having a head or hooked end and a fully or partially threaded body

_______b. Wood or metal fasteners consisting of a tapered, threaded shank and a head designed to allow turning of the fastener

_______c. Nails with a smooth shaft and a very small barrel-shaped head that creates a small void in the surface of the workpiece

_______d. Fasteners consisting of a straight, slender piece of metal with one pointed end and one end that is struck with hammer or driven with pneumatic or powder-actuated gun

_______e. Method of using high electrical voltage to create intense heat that then bonds a steel welding rod to structural members to be joined

_______f. Nails with a smooth cylindrical shaft and a flat head

1. Nails
2. Common nails
3. Finish nails
4. Screws
5. Bolts
6. Welds

9. Match types of glazing products commonly used in construction to their correct descriptions. Write the numbers on the blanks provided. Products and descriptions continue on the next page.

_______a. Glass manufactured by separating layers of sheet glass with a ⅛- to 1-inch air space that is then sealed

_______b. Glass in which wire mesh is embedded between two layers of sheet glass, resulting in a safety glass that prevents the glass from shattering if broken

_______c. Clear or opaque glass material manufactured in continuous, long flat pieces and cut to desired sizes and shapes

1. Sheet glass
2. Wired glass
3. Insulated glass

WRITTEN TEST

______d. Glazing product manufactured from clear or opaque synthetic materials

______e. Colored glass produced by adding small amounts of chemical elements to the molten glass mixture

______f. Glass manufactured by bonding transparent vinyl between layers of sheet glass, resulting in a safety glass that adheres to the vinyl if broken

______g. Glass produced with different surface designs that obscure vision but allow light transmission

______h. Glass manufactured by reheating and then rapidly cooling cut glass, resulting in a glass that is much more resistant to thermal stress and impact

4. Laminated glass
5. Tempered glass
6. Pattern glass
7. Tinted glass
8. Plastic

10. Describe types of thermal-insulation materials commonly used in construction. Write your answers on the blanks provided.

a. Batt insulation ____

____

____

____

____

b. Loose-fill insulation ____________________________________

____

____

____

____

c. Rigid-sheet insulation ___________________________________

____

____

____

____

WRITTEN TEST

11. Match thermal-insulation applications to their correct descriptions. Write the numbers on the blanks provided.

______a. Rigid-sheet insulation placed below a concrete slab to provide resistance to heat conduction from the concrete slab

______b. Batt or rigid-sheet insulation placed below the floor framing to provide resistance to heat conduction into the crawl-space area

______c. Batt or loose-fill insulation placed above the ceiling framing to provide resistance to heat conduction into the area above the ceiling

______d. Insulation wrapped around heating and cooling ductwork to reduce heat or cooling loss from the ducts

______e. Any of the various types of thermal insulation placed between structural wall members to provide resistance to heat conduction in and out of the building

______f. Batt or rigid-sheet insulation installed over a building's concrete foundation wall

1. Ceiling insulation
2. Floor insulation
3. Perimeter insulation
4. Wall insulation
5. Duct insulation
6. Slab insulation

12. Match types of damp-proofing and drainage materials commonly used in construction to their correct descriptions. Write the numbers on the blanks provided. Materials and their descriptions continue on the next page.

______a. Pipe with a series of holes; pipe is placed outside foundation walls at footing to channel groundwater away from structure by gravity

______b. Pipes and panels used with channels or trenches to convey groundwater away from structure

______c. Liquid brushed on wood and other porous materials to prevent water penetration

______d. Materials that prevent the flow of groundwater into structural members

1. Damp-proofing materials
2. Perforated drain pipe
3. Drainage-system materials
4. Water repellant

WRITTEN TEST

_____e. Asphalt-based liquid brushed or sprayed onto foundation walls to seal concrete and prevent groundwater penetration into foundation

_____f. Panel constructed of an open porous material with a fabric filter exterior; when panel is attached to foundation walls, fabric filter allows groundwater to enter panel, where it is channelled downward and emptied into drainage pipe

_____g. Corrugated cardboard sheets with internal cells filled with dry bentonite clay; when applied to foundation walls and then saturated with water, the sheets expand and form a continuous nonporous membrane over foundation walls

_____h. Flexible plastic sheets placed between concrete-slab floors and grade to act as a vapor barrier to prevent groundwater from penetrating upward into slab floor

5. Damp-proof coatings
6. Bentonite-clay sheets
7. Polyethylene sheeting
8. Drainage panel

13. Label common construction-material symbols used on architectural drawings. Symbols are shown in the drawing on the next page. Write your answers on the blanks provided below.

a. ______________________________

b. ______________________________

c. ______________________________

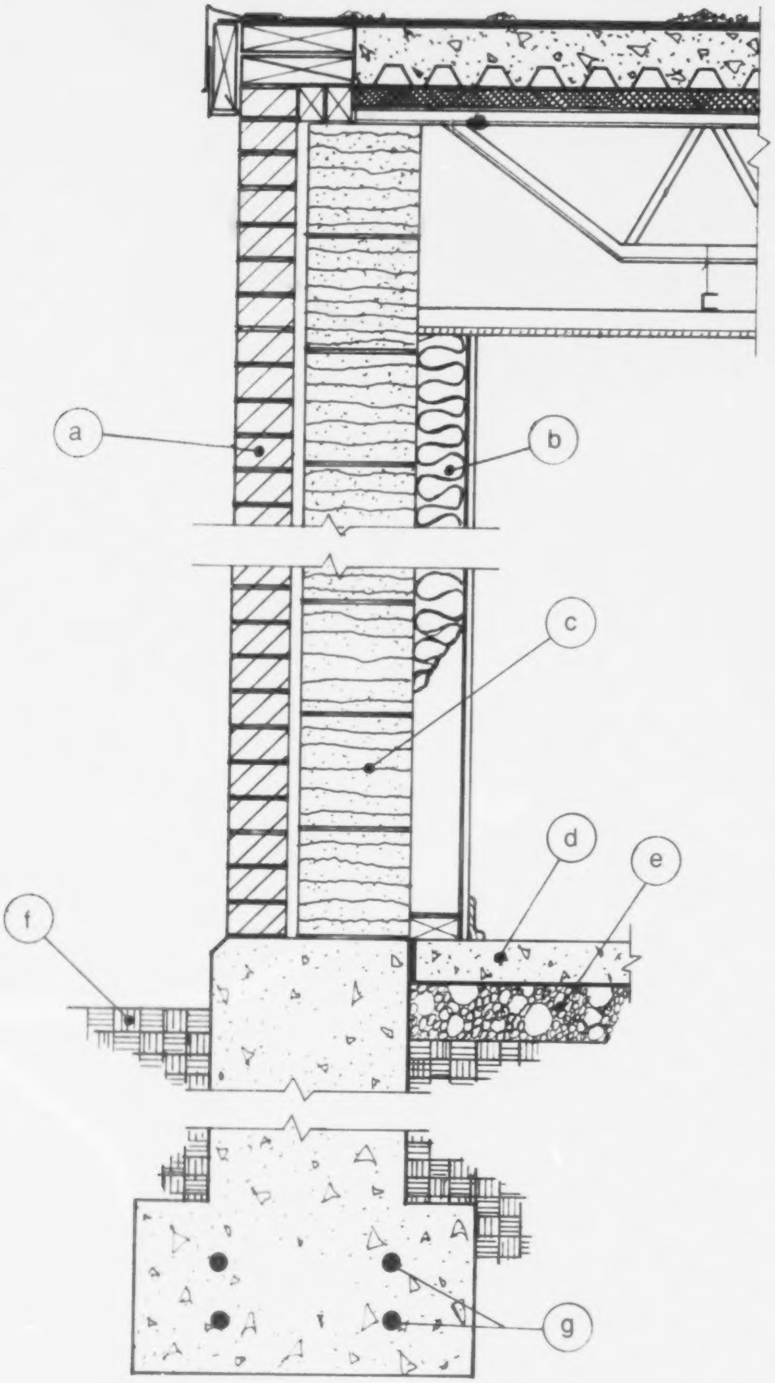
d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

WRITTEN TEST



SITE CONDITIONS
UNIT 3

UNIT OBJECTIVE

After completing this unit, the student should be able to analyze a potential construction site, develop property-survey and plot-plan drawings, and determine cut and fill designations. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with site conditions to their correct definitions.
2. Discuss general questions considered in conducting a site analysis.
3. Describe climate-orientation factors considered in conducting a site analysis.
4. Match physical characteristics of a site considered in conducting a site analysis to their correct definitions.
5. Match site-clearing and removal practices considered when conducting a site analysis to their correct definitions.
6. Define types of drawings commonly completed as part of a site analysis.
7. Identify components of a property survey.
8. List components of a plot plan.
9. Label symbols commonly used on a plot plan.
10. Match components of a grading plan to their correct definitions.
11. Analyze a potential construction site. (Assignment Sheet 1)
12. Draw a property survey. (Assignment Sheet 2)
13. Draw a plot plan. (Assignment Sheet 3)
14. Determine required cut and fill designations. (Assignment Sheet 4)

SITE CONDITIONS
UNIT 3

SUGGESTED ACTIVITIES

Preparation

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery and Application" section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.
- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section.
- Make transparencies from the transparency masters included in this unit.
- Duplicate the teacher supplement included in this unit, as required.
- Prepare classroom and lab. Put up posters, charts, and signs; display articles and other references related to the objectives of this unit.

Delivery and Application

Unit introduction

- Provide students with objective sheet. Discuss unit and specific objectives.
- Provide students with information and assignment sheets.
- Show the film *Plot Plans and Landscape Plans*. Hold a class discussion afterwards to answer any student questions or comments.
- Have students make a list of characteristics they would look for in selecting a building site. At the end of the unit, have them compile another list of what they would look for in a building site. Compare and discuss the differences in the lists.
- Discuss information sheet.

Objective 1 Match terms associated with site conditions to their correct definitions.

- Show examples that illustrate terms and make examples available in the classroom.

SUGGESTED ACTIVITIES

Objective 2 Discuss general questions considered in conducting a site analysis.

- Read to the class the note introducing the objective and then emphasize to the class the importance of site selection. Discuss each of the items in the objective, using examples of commercial buildings in your area to help illustrate your discussion.
- Show the class photos of various commercial buildings and discuss their sites. List for the class the advantages and disadvantages of each site photographed.
- Explain the purposes of zoning ordinances and regulations. Examine how zoning laws have affected a city in your area. Discuss, for example, where residential, commercial, and industrial areas are concentrated.
- Provide site plans from your area and discuss local zoning ordinances, regulations, and amendments to the zoning laws that have permitted unusual mixtures of residential, commercial, retail, and industrial areas.

Objective 3 Describe climate-orientation factors considered in conducting a site analysis.

- Read to the class the note introducing this objective, explaining the impact that climatic orientation will have on a building (i.e., effects of energy usage, control of natural light, selection of building materials, etc.).
- Show students how to read solar-orientation tables. Hand out copies of Teacher Supplement 1, "Altitude and Azimuth Considerations." Explain the importance of the sun's altitude and azimuth. Look up in *Architectural Graphic Standards* the altitude and azimuth for a city in your area.

Objective 4 Match physical characteristics of a site considered in conducting a site analysis to their correct definitions.

- Read to the class the note introducing the objective. Emphasize the importance of developing a site that complements the physical characteristics of the site as well as the structure to be built.
- Give students sample contour maps and profiles. Have them place a structure on the contour map and explain their reasoning.

SUGGESTED ACTIVITIES

Objective 5 Match site-clearing and removal practices considered when conducting a site analysis to their correct definitions.

- Read to the class the note introducing the objective. Explain the cost and time factors that must be considered in preparing a site for construction.
- Visit an open site in a commercial building area. Give the students a hypothetical building plan to be constructed on the site and have them discuss what site-clearing practices would be required to prepare the site for construction.
- Review with students the site-analysis factors they have discussed in Objectives 2 through 5 in the information sheet. Then hand out and discuss Assignment Sheet 1, "Analyze a Potential Construction Site." Hand out and discuss the use of Student Supplement 1, "Rough Sketches of Two Commercial Buildings." Have students complete Assignment Sheet 1.

Objective 6 Define types of drawings commonly completed as a part of a site analysis.

- Read with students the definitions of a property survey, plot plan, and grading plan listed in the objective. Show samples of each type of plan and discuss the similarities and differences to be found in these types of plans. For example, explain that a plot plan is derived from a property survey and emphasize the similarities and differences in these two types of plans.

Objective 7 Identify components of a property survey.

- Read with students the listing of property-survey components given in the information sheet, and use Transparency 1, "Property Survey" and Figure 2 in the information sheet to locate these components on the sample plan.
- Explain the process of developing a property survey; use Transparency 1 to illustrate your discussion.
- Hand out Assignment Sheet 2, "Draw a Property Survey." Read with students the introduction to the assignment sheet and discuss directions for completing the assignment. Have students complete Assignment Sheet 2.

Objective 8 List components of a plot plan.

Objective 9 Label symbols commonly used on a plot plan.

SUGGESTED ACTIVITIES

- Treat Objectives 8 and 9 as a unit. Discuss the components of a plot plan and the symbols commonly used on a plot plan. Use Transparencies 2 thorugh 4 to illustrate your discussion.
- Draw each of the plot-plan symbols on the chalkboard; discuss the drawing procedure for each and its correlation to the item it represents.
- Hand out Student Supplement 2, "Steps in Completing a Plot Plan." Discuss the necessity of drawing a plot plan in an organized and complete manner. Discuss the plot plan's function as a part of the construction process.
- Hand out Assignment Sheet 3, "Draw a Plot Plan." Read the introduction and directions, answering any questions students may have. Have students complete Assignment Sheet 3.

Objective 10 Match components of a grading plan to their correct definitions.

- Read with students the note introducing the objective in the information sheet. Explain the function of a grading plan in relation to a construction project.
- Show students examples of contour maps and have them interpret features such as hilltops, ground depressions, and river beds.
- Hand out Student Supplement 3, "Methods of Designating Cut and Fill Requirements." Discuss the concept of cut and fill for grading plans. Use the graphics in the student supplement to explain how cut and fill areas are designated.
- Use Transparency 5, "Profile," to explain how to develop a site profile and the usefulness of a site profile in visualizing the shape of the overall terrain on a building site.
- Hand out Assignment Sheet 4, "Determine Required Cut and Fill Designations." Read with students the introduction and directions to the assignment. Have students complete Assignment Sheet 4.

Evaluation

- Give written test.
- Compile written-test and assignment-sheet scores on Unit Evaluation Form.
- Reteach and retest as required.

SUGGESTED ACTIVITIES

Suggested Resources

Resources used in developing unit

Print media

- Harris, Cyril M. *Dictionary of Architecture and Construction.* New York: McGraw-Hill, 1983.
- Lynch, Kevin. *Site Planning.* Cambridge, Massachusetts: MIT Press, 1984.
- Putnam, Robert. *Building Trades Blueprint Reading.* Reston, Virginia: Reston Publishing (Prentice-Hall Co.), 1986.
- Spence, William P. *Architecture—Design, Engineering, Drawing.* Bloomington, Illinois: Glencoe, Bennett & McKnight, 1985.

Additional resources

Print media

- Muller, Edward J. *Architectural Drawing and Light Construction.* Englewood Cliffs, New Jersey: Prentice-Hall, 1985.
- Ramsey, Charles. *Architectural Graphic Standards,* 8th ed. New York: Wiley & Sons, 1988.
- Wattles, Gurdon H. *Survey Drafting.* Orange, California: Gurdon H. Wattles Publications, 1982.

Media

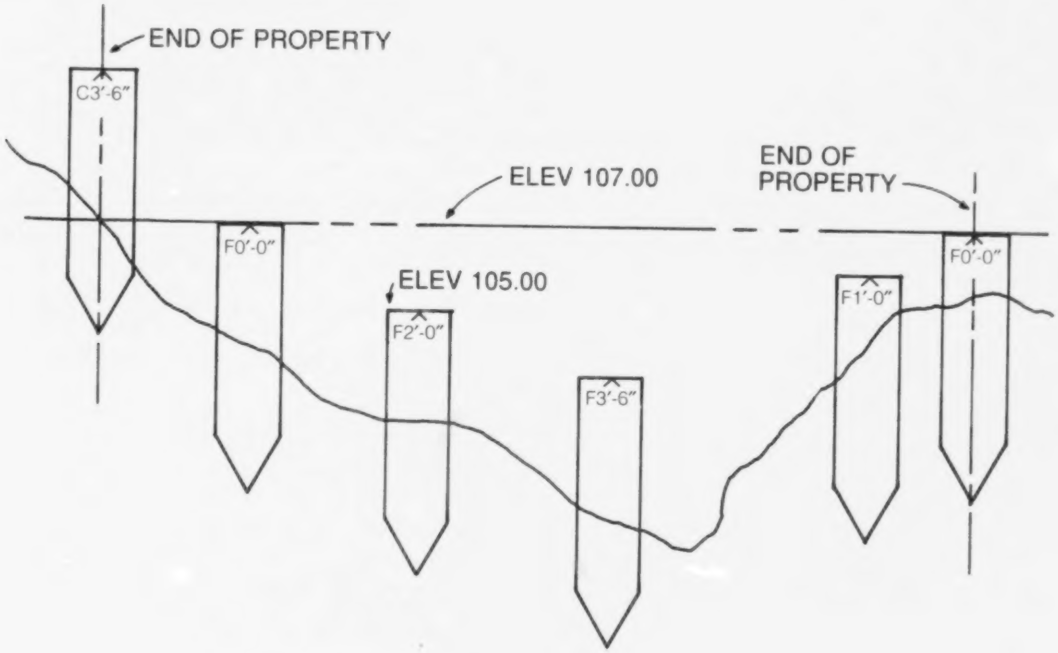
- *Plot Plans and Landscape Plans.* No copyright date. Filmstrip, VHS, approximately 15 minutes in length. Order number 6504, Hearlihy and Co., 714 West Columbia Street, Springfield, Ohio 45501.

  This visual presentation identifies legal requirements for plot plans and shows how property lines are identified according to a site's legal description. The presentation also discusses landscaping and how it affects the overall building project.

SITE CONDITIONS
UNIT 3

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1	Evaluated to the satisfaction of the instructor.
Assignment Sheet 2	Evaluated to the satisfaction of the instructor.
Assignment Sheet 3	Evaluated to the satisfaction of the instructor.
Assignment Sheet 4	


END OF PROPERTY
C3'-6"
ELEV 107.00
END OF PROPERTY
F0'-0"
ELEV 105.00
F2'-0"
F3'-6"
F1'-0"
F0'-0"

SITE CONDITIONS
UNIT 3

ANSWERS TO WRITTEN TEST

1. a. 8
   b. 6
   c. 2
   d. 1
   e. 4
   f. 9
   g. 3
   h. 5
   i. 7

2. a. Functional adequacy of site

   (1) Is there enough physical space on the site to accommodate the structure?
   (2) Will the soil on the site support the structure?
   (3) Is the water table too high or too low to accommodate the structure?

   b. Cost of site

   (1) Will the initial cost of the site be reasonable?
   (2) What will be the future costs associated with the property-tax structure of the area?
   (3) What will be the future costs associated with the clearing and removal that may be required in order to prepare the site for construction?

   c. Site adaptability

   (1) Will the site be able to accommodate design changes prior to completion of the structure?
   (2) Will the site be able to accommodate future expansion?

   d. Site accessibility

   (1) Is the site easily accessible to clients or customers by road? by rail? by air?
   (2) Is the site easily accessible to surrounding businesses?

   e. Site's availability to adequate utilities

   (1) Does the site location allow for the convenient hookup of utilities such as water, electric, gas, telephone, and street lighting?
   (2) Will the cost of these utilities be reasonable at the site?

   f. Clear title

   (1) Has an accurate property survey been made of the site to establish specific boundaries and provide information as to the exact location of the site?
   (2) Has an investigation been conducted to determine that the site has a clear title and there are no liens against the property?

ANSWERS TO WRITTEN TEST

g. Zoning regulations

   (1) Have zoning regulations been checked to make sure there are no restrictions that may prevent construction of the particular type of structure to be built? or that may delay construction of the structure?
   (2) Will the site meet zoning restrictions as to minimum lot size?
   (3) Will the structure meet restrictions as to maximum building height, minimum floor space, etc.?
   (4) If variances are required in zoning regulations to accommodate the structure, how difficult will they be to obtain?

h. Easements and setback allowances

   (1) If there are easements, will any cause inconvenience, expense, or difficulty before or after the structure is built?
   (2) Have setback allowances been accommodated for the type of structure to be built?

3. a. Prevailing-wind considerations are considerations instituted either to accommodate or block the normal surface-wind directions associated with an area

   (1) Summer winds are predominately from the southwest; therefore, a structure should be oriented so that southwest winds can blow through windowed areas of the structure
   (2) Winter winds are predominately from the northwest; therefore, a structure should be oriented so that cold northwest winds will be blocked

b. Thermal-radiation considerations are considerations instituted either to accommodate or block the transmission of heat energy into a structure

   (1) The south wall of a structure receives sustained and intense exposure to the sun; this means that the south wall of a structure will be well-illuminated all day but will also receive considerable heat from the direct rays of the sun; therefore, it is necessary to provide a deep overhang or some other means of breaking the sun's rays during the heat of the day
   (2) The north wall of a structure receives only a small amount of direct sunlight; areas of the structure that do not require a great deal of solar light should be oriented to the north
   (3) The east wall of a structure receives only early morning sunshine, which is usually moderate and pleasant; orient high windows on an east exposure so pleasant early morning rays will enter the rooms off this exposure
   (4) The west wall of a structure receives intensive periods of heat from rays striking at low angles in the afternoon; utilize devices such as trees, fences, or awnings on the west wall to control the sun's rays through windowed areas

ANSWERS TO WRITTEN TEST

4. a. 2
   b. 3
   c. 6
   d. 5
   e. 1
   f. 4

5. a. 3
   b. 5
   c. 2
   d. 1
   e. 4

6. a. Drawing that establishes specific boundaries, that provides information as to the exact location of a site, and that shows elevations, topography, and man-made features of the site
   b. Drawing that shows the top view of a site and indicates the placement of structures, utilities, easements, and other information necessary for construction
   c. Drawing that shows the existing and proposed finish elevation of the earth's surface on a specific site

7. a. Elevation contours
   b. Legal boundaries
   c. Easements
   d. Topographical features
   e. Compass orientation
   f. Existing man-made entities

8. Answer should include any 8 of the following

   a. Length and bearing of each property line
   b. Contour lines
   c. Elevations of property corners, contour lines, and structure's finish floor
   d. North arrow
   e. Building lines
   f. Location, outline, and dimensions of structures on site
   g. Streets, driveways, parking areas, sidewalks, and medians
   h. Location of utility lines
   i. Location and width of easements
   j. Fences and retaining walls
   k. Legal description and address of site
   l. Scale of drawing

9. a. Property line
   b. Tree
   c. Dry cracked clay
   d. Existing contour
   e. Property corner
   f. Water
   g. Sanitary sewer
   h. Power line
   i. Water line
   j. Gas line
   k. Cultivated area
   l. Sand
   m. Benchmark
   n. Spot elevation
   o. Ground cover
   p. Large stones
   q. Well
   r. Proposed contour

ANSWERS TO WRITTEN TEST

10. a. 3
    b. 1
    c. 2
    d. 4

SITE CONDITIONS
UNIT 3

UNIT EVALUATION FORM

Student name ______________________________ Unit rating __________

Assignment sheet ratings

Assignment Sheet 1—Analyze a Potential Construction Site Rating __________

Comments: ______________________________

____

Assignment Sheet 2—Draw a Property Survey Rating __________

Comments: ______________________________

____

Assignment Sheet 3—Draw a Plot Plan Rating __________

Comments: ______________________________

____

Assignment Sheet 4—Determine Required Cut and Fill Designations Rating __________

Comments: ______________________________

____

Written test scores

Pretest __________ Other __________

Posttest __________

Instructor signature ______________________________ Date __________

Student signature ______________________________ Date __________

Duplication of this form is permitted.

SITE CONTITIONS
UNIT 3

TEACHER SUPPLEMENT 1—ALTITUDE AND AZIMUTH CONSIDERATIONS

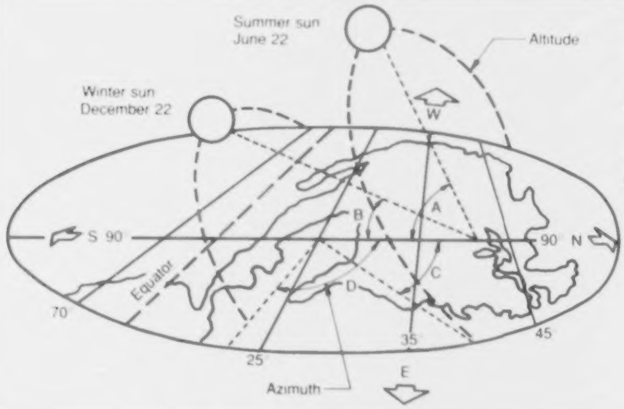
The determination of the sun's impact upon a given location can be understood by examining two elements—solar altitude and solar azimuth.

Solar altitude

Solar altitude is defined as "the angle formed between the sun's directional rays and the earth's surface (horizon)."

Due to the earth's rotation around the sun, the sun's altitude (for the northern hemisphere) is lower in the winter and higher in the summer. This factor largely determines the design and placement of a structure on a given site.

Altitude angles can be calculated from charts provided in most architectural design standards books.



Angle A is the altitude of the sun at Milwaukee at noon on June 22.

Angle B is the altitude on December 22.

Angle C is the azimuth at sunrise in Milwaukee on June 22.

Angle D is the azimuth on December 22.

Reprinted with permission of Glencoe Division of Mcmillan/McGraw-Hill School Publishing Company from *Architecture—Design, Engineering, Drawing* by William P. Spence, copyright 1985.

Solar azimuth

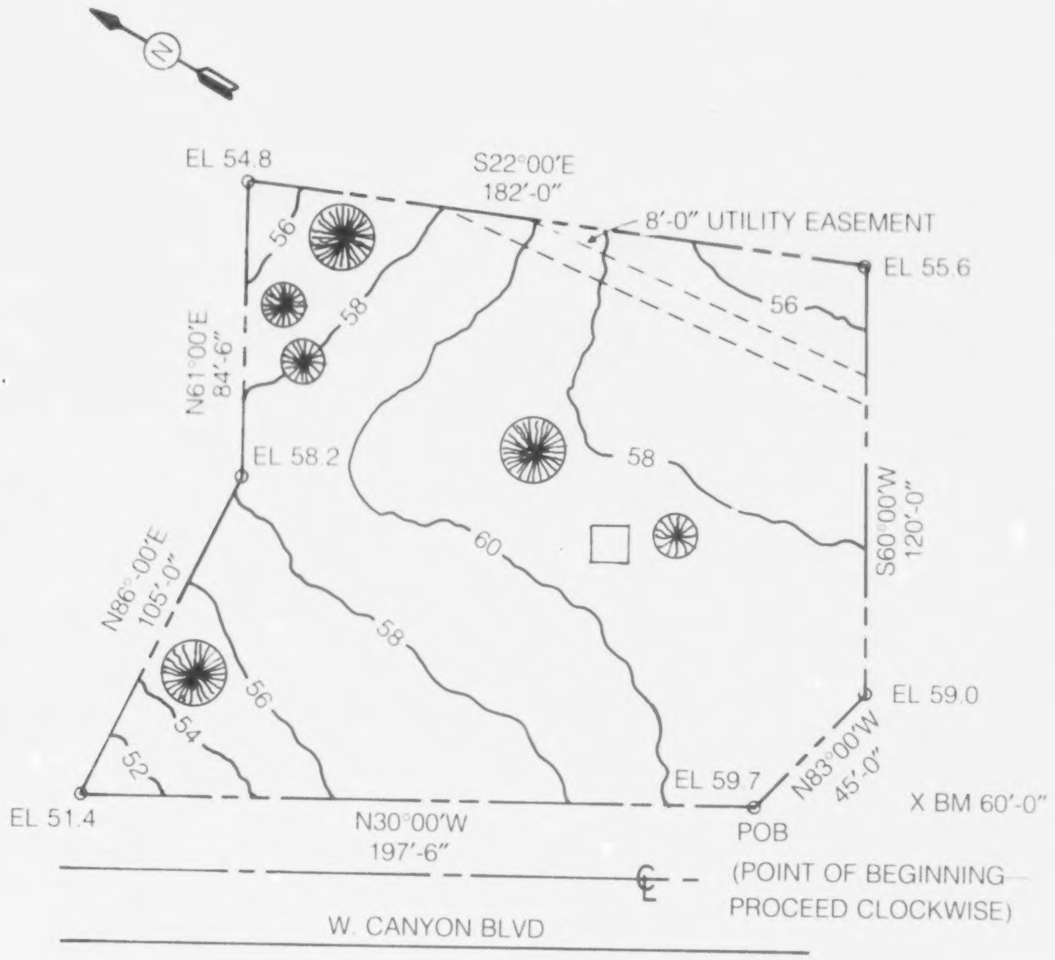
Solar azimuth is defined as "the angular distance (in degrees) as measured from true south to a point on the earth's surface directly below the sun."

By utilizing information concerning both solar azimuth and solar altitude, the solar intensity of the sun can be determined at given times of the day during various times of the year.

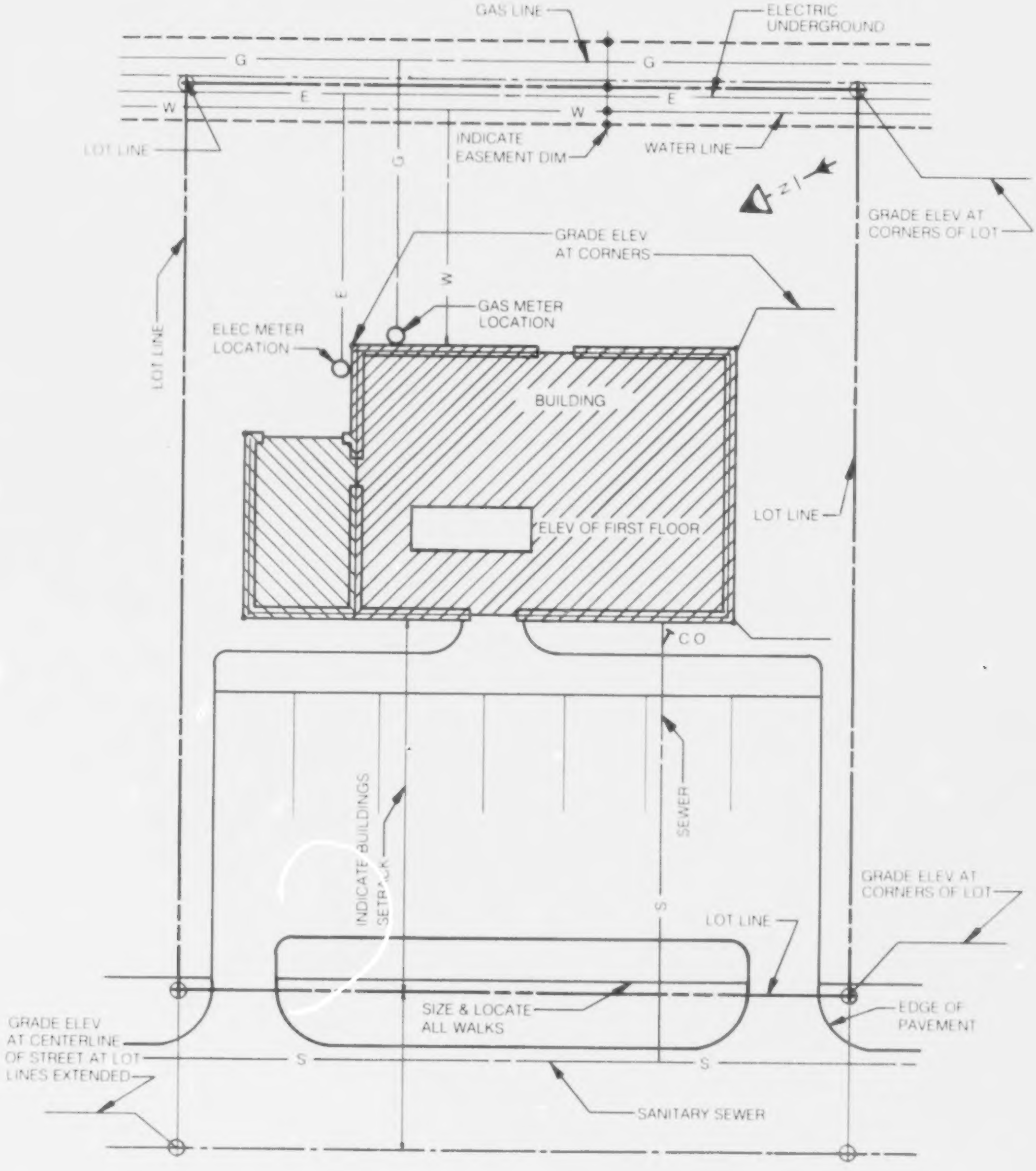
Azimuth angles can be calculated from charts provided in most architectural design standards books.

Duplication of this teacher supplement is permitted.

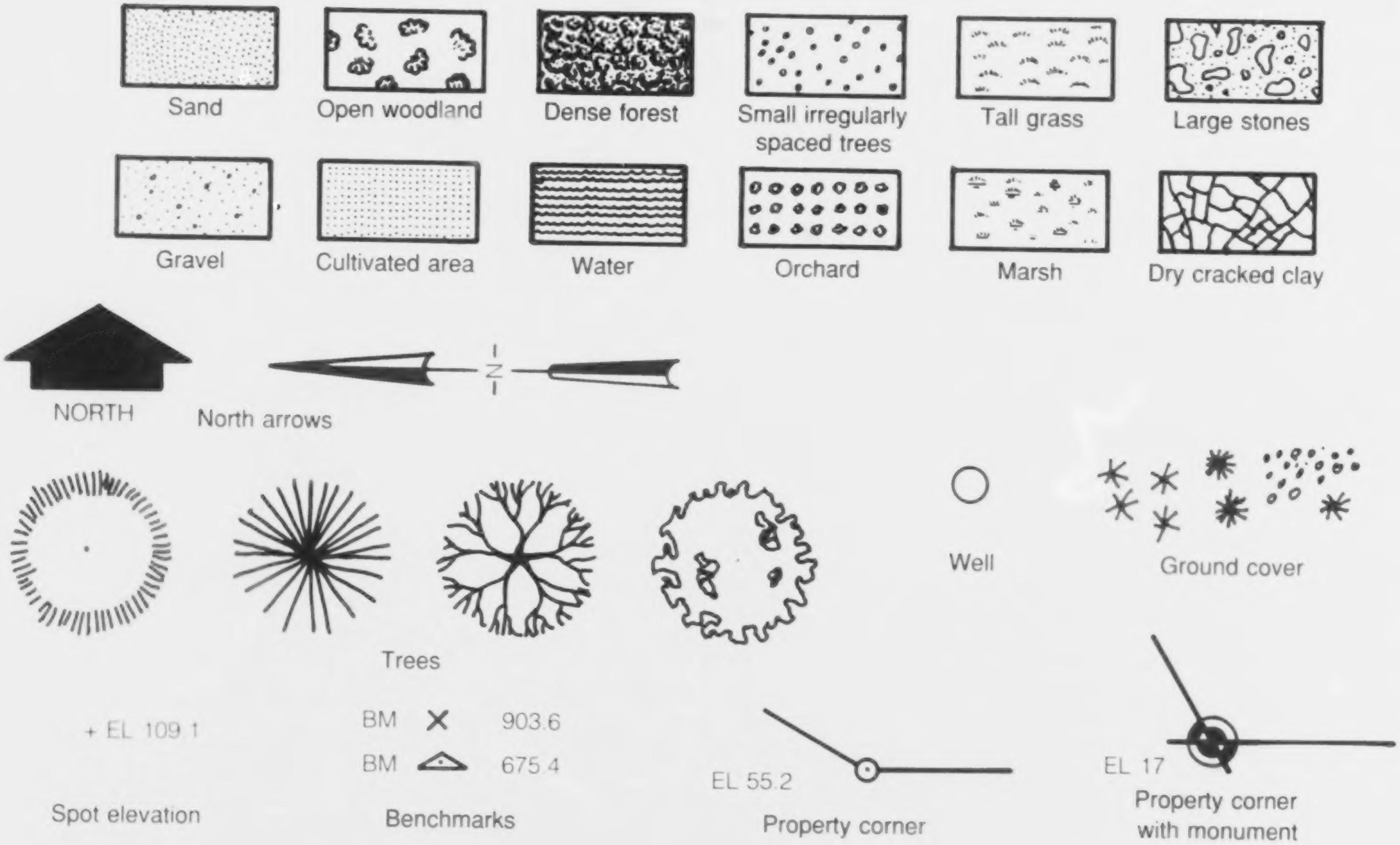
Property Survey (Site Plan)


N
EL 54.8
S22°00'E
182'-0"
8'-0" UTILITY EASEMENT
EL 55.6
56
58
56
N61°00'E
84'-6"
EL 58.2
58
60
S60°00'W
120'-0"
N86°-00'E
105'-0"
58
56
54
52
EL 59.0
EL 59.7
N83°00'W
45'-0"
X BM 60'-0"
EL 51.4
N30°00'W
197'-6"
POB
(POINT OF BEGINNING—
PROCEED CLOCKWISE)
℄
W. CANYON BLVD

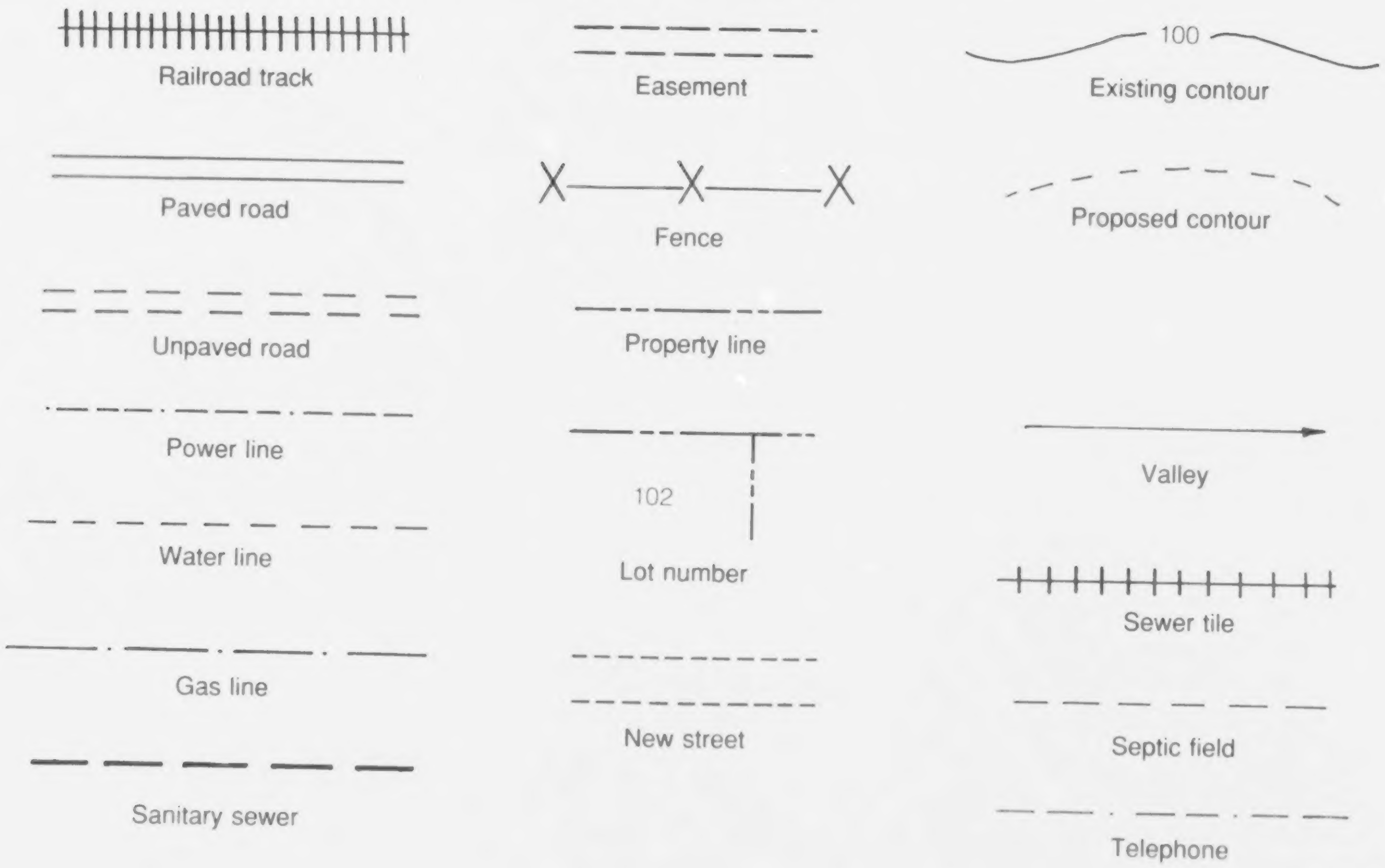
Plot Plan


GAS LINE
ELECTRIC UNDERGROUND
G
G
E
E
W
W
LOT LINE
INDICATE EASEMENT DIM
WATER LINE
N
GRADE ELEV AT CORNERS OF LOT
GRADE ELEV AT CORNERS
G
E
W
GAS METER LOCATION
ELEC METER LOCATION
LOT LINE
BUILDING
ELEV OF FIRST FLOOR
LOT LINE
CO
INDICATE BUILDINGS SETBACK
SEWER
S
GRADE ELEV AT CORNERS OF LOT
LOT LINE
SIZE & LOCATE ALL WALKS
EDGE OF PAVEMENT
GRADE ELEV AT CENTERLINE OF STREET AT LOT LINES EXTENDED
S
S
SANITARY SEWER

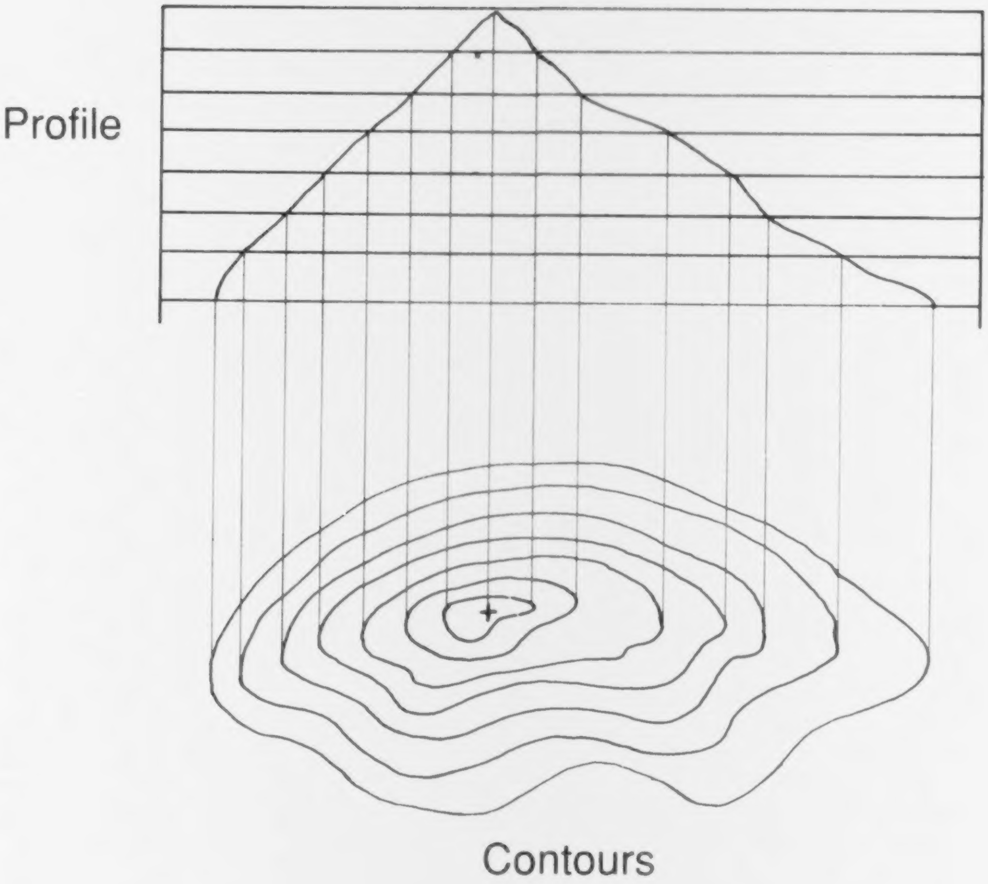
Plot-Plan Symbols


Sand
Open woodland
Dense forest
Small irregularly spaced trees
Tall grass
Large stones
Gravel
Cultivated area
Water
Orchard
Marsh
Dry cracked clay
NORTH
N
North arrows
Well
Ground cover
Trees
+ EL 109.1
Spot elevation
BM 903.6
BM 675.4
Benchmarks
EL 55.2
Property corner
EL 17
Property corner with monument

Plot-Plan Symbols
(Continued)


Railroad track
Paved road
Unpaved road
Power line
Water line
Gas line
Sanitary sewer
Easement
Fence
Property line
102
Lot number
New street
100
Existing contour
Proposed contour
Valley
Sewer tile
Septic field
Telephone

Profile


Profile
Contours

Profile drawn from a contour map. The profile shows what land looks like in side view - as if the hill were cut vertically.

SITE CONDITIONS
UNIT 3

INFORMATION SHEET

1. **Terms and definitions associated with site conditions**

   a. **Benchmark**—Permanent reference point of known elevation from which other points can be measured

   b. **Building line**—Established line on a property beyond which a structure may not extend

   c. **Contour line**—Line on a drawing representing points of equal elevation

   d. **Elevation**—Vertical distance measured above or below an established reference point (such as sea level)

   e. **Finish-floor elevation**—Height of finish floor upon completion of structure

   f. **Lien**—Charge placed upon property until some debt is satisfied

   g. **Site**—Building location

   h. **Title**—Instrument (deed) that is evidence of ownership

   i. **Water table**—Upper limit of the portion of the ground that is saturated with water

2. **General questions considered in conducting a site analysis**

   NOTE: Before the actual planning of a construction project begins, the architect must give a great deal of study to site considerations—the physical characteristics of the site and laws and regulations associated with the area. Then he or she makes every effort to accommodate these considerations in planning the structure. The goal of the plan should be a structure that appears to be part of the site, a structure that blends in with the site rather than stands apart from it, and a site that can allow for all the required technical necessities of the structure. The following items and questions associated with each item are considered in making this careful study of the site.

   a. **Functional adequacy of site**

      (1) Is there enough physical space on the site to accommodate the structure?

      (2) Will the soil on the site support the structure?

      (3) Is the water table too high or too low to accommodate the structure?

   b. **Cost of site**

      (1) Will the initial cost of the site be reasonable?

BEST COPY AVAILABLE

INFORMATION SHEET

(2) What will be the future costs associated with the property-tax structure of the area?

(3) What will be the future costs associated with the clearing and removal that may be required in order to prepare the site for construction?

c. **Site adaptability**

(1) Will the site be able to accommodate design changes prior to completion of the structure?

(2) Will the site be able to accommodate future expansion?

d. **Site accessibility**

(1) Is the site easily accessible to clients or customers by road? by rail? by air?

(2) Is the site easily accessible to surrounding businesses?

e. **Site's availability to adequate utilities**

(1) Does the site location allow for the convenient hookup of utilities such as water, electric, gas, telephone, and street lighting?

(2) Will the cost of these utilities be reasonable at the site?

f. **Clear title**

(1) Has an accurate property survey been made of the site to establish specific boundaries and provide information as to the exact location of the site?

(2) Has an investigation been conducted to determine that the site has a clear title and there are no liens against the property?

g. **Zoning regulations**

(1) Have zoning regulations been checked to make sure there are no restrictions that may prevent construction of the particular type of structure to be built? or that may delay construction of the structure?

(2) Will the site meet zoning restrictions as to minimum lot size?

(3) Will the structure meet restrictions as to maximum building height, minimum floor space, etc.?

INFORMATION SHEET

(4) If variances are required in zoning regulations to accommodate the structure, how difficult will they be to obtain?

NOTE: Zoning ordinances and regulations are developed by public governing boards to help plan communities in an organized manner and to control a random mixing of residential, commercial, and industrial structures that may prove economically unhealthy in future years. Although variances in zoning regulations may be obtained through a governing board or by a vote of the residents in the affected area, obtaining variances can be difficult or impossible.

h. Easements and setback allowances

(1) If there are easements, will any cause inconvenience, expense, or difficulty before or after the structure is built?

NOTE: Easements are rights of access onto another's property for specific purposes. These purposes include, for example, the placement of electric, telephone, and cable-TV utilities.

(2) Have setback allowances been accommodated for the type of structure to be built?

NOTE: Setback allowances (setbacks) are required distances between a structure on a piece of property and the property lines at the front, side, and rear of the property. Setbacks are often dependent on the use of the structure to be built.

3. Climate-orientation factors considered in conducting a site analysis and their descriptions

NOTE: Climate orientation of a structure is an important aspect of a site analysis. Factors that need to be considered are prevailing winds, temperature, solar radiation, and the use of existing topography (i.e., trees, shrubs, earth berms). Proper utilization of these aspects provides an energy-efficient structure and also allows for a harmonious relationship between the structure and the site. The following factors apply to structures located in the adjacent 48 states of the United States. Generally, it is not possible to incorporate all the factors involved into a final plan for the structure and site, but each should be considered to eliminate as many adverse factors as possible.

a. **Prevailing-wind considerations**—Considerations instituted either to accommodate or block the normal surface-wind directions associated with an area

(1) **Summer winds**—Summer winds are predominately from the southwest; therefore, a structure should be oriented so that southwest winds can blow through windowed areas of the structure

NOTE: If something on the site, such as a hill or growth of trees, blocks the summer breezes, the designer must rely more on air conditioning to cool the structure.

INFORMATION SHEET

(2) **Winter winds**—Winter winds are predominately from the northwest; therefore, a structure should be oriented so that cold northwest winds will be blocked

NOTE: Solid walls of a structure, or walls with very few windows, are oriented to the northwest to keep winter winds from entering a structure, or windowed walls oriented toward the northwest may be blocked by the use of trees or hedges in the landscape.

b. **Thermal-radiation considerations**—Considerations instituted either to accommodate or block the transmission of heat energy into a structure

(1) **Southern exposure**—The south wall of a structure receives sustained and intense exposure to the sun; this means that the south wall of a structure will be well-illuminated all day but will also receive considerable heat from the direct rays of the sun; therefore, it is necessary to provide a deep overhang or some other means of breaking the sun's rays during the heat of the day

NOTE: Although a southern exposure often requires an overhang to block the sun's rays during the heat of the day, large areas of glass can still be used in the winter as a solar collector to both light and heat rooms off of this exposure.

(2) **Northern exposure**—The north wall of a structure receives only a small amount of direct sunlight; areas of the structure that do not require a great deal of solar light should be oriented to the north

(3) **Eastern exposure**—The east wall of a structure receives only early morning sunshine, which is usually moderate and pleasant; orient high windows on an east exposure so pleasant early morning rays will enter the rooms off this exposure

(4) **Western exposure**—The west wall of a structure receives intensive periods of heat from rays striking at low angles in the afternoon; utilize devices such as trees, fences, or awnings on the west wall to control the sun's rays through windowed areas

4. Physical characteristics of a site considered in conducting a site analysis and their definitions

NOTE: In the development of a site, a planned effort should be made to minimize the area of the site that must be disturbed. In addition, impact to the environment must also be considered. A well-developed site analysis will address the functional necessities of the structure to be built while at the same time allowing for the natural physical setting of the site to remain relatively intact.

Large projects, projects that are in part federally funded, or projects in urban areas may require the filing of an environmental-impact statement (EIS) that describes the areas of the site to be developed and analyzes what effects the site development will have on the environment.

a. **Slope**—Upward or downward slant of land, or inclination or degree of that slant

NOTE: The slope of the land should be kept as gentle as possible to prevent a high velocity of water runoff that would create soil erosion.

INFORMATION SHEET

b. **Swales**—Depressions in the ground often designed for channeling surface water around a structure

c. **Channels**—Man-made ditches used to divert water runoff and minimize water flow to help prevent soil erosion

d. **Sediment ponds**—Water basins that prevent soil sediment from entering sewers and/or waterways

e. **Earth berms**—Continuous embankments of earth that help control flooding and soil erosion during heavy rains and help reduce noise from outside sources

f. **Retaining walls**—Concrete, brick, or railroad-tie walls built to hold earth on steep slopes

5. **Site-clearing and removal practices considered when conducting a site analysis and their definitions**

NOTE: As a part of the site analysis, a removal plan must be developed that will consider what will be done with excess dirt and other obstacles created during the site-development process. A removal plan is normally created by the architect and the contractor responsible for site-clearing and excavation. This plan can be as simple as verbal instructions or as complex as a drawing indicating where, when, and how clearing methods and equipment are to be used. In accomplishing this removal plan, the architect and contractor may choose from any of the site-clearing practices listed below.

a. **Demolishing**—Smashing natural or man-made obstacles by blasting (using explosives), wrecking (using bulldozers and wrecking ball), or using hand tools such as crowbars and saws

b. **Salvaging**—Rescuing from wreckage certain materials of future value

EXAMPLES: Mature trees, large boulders to be used for landscaping, excess building materials, topsoil

c. **Cutting**—Felling trees or removing topographical features that would interfere with contruction on the site

d. **Burning**—Destroying obstacles through the use of a controlled fire

EXAMPLE: Burning unusable vegetation

e. **Disposing**—Hauling away unwanted materials

NOTE: Disposal is a very costly option used in clearing a site for construction.

6. **Types of drawings commonly completed as a part of a site analysis and their defintions**

a. **Property survey** (site plan)—Drawing that establishes specific boundaries, that provides information as to the exact location of a site, and that shows elevations, topography, and man-made features of the site (see Figure 2)

INFORMATION SHEET

b. **Plot plan**—Drawing that shows the top view of a site and indicates the placement of structures, utilities, easements, and other information necessary for construction (see Figure 4)

NOTE: A plot plan is derived from information from a property survey.

c. **Grading plan**—Drawing that shows the existing and proposed finish elevation of the earth's surface on a specific site

7. **Components of a property survey** (see Figure 2)

NOTE: Property surveys (also called *site plans*) involve the preparation of geographic data into a drawing that includes both natural and man-made characteristics of a designated site. Some of the preliminary information used in devleoping a property survey is derived from a topographical plan of the site.

a. **Legal boundaries**

NOTE: Legal boundaries are established on the drawing by the use of property lines.

b. **Easements**

NOTE: Any rights of access (easements) need to be surveyed and documented on the drawing.

c. **Existing man-made entities**

EXAMPLES: Existing utilities, roads, buildings, retaining walls

d. **Topographical features**

EXAMPLES: Trees, rock outcroppings, bodies of water, vegetation cover

e. **Elevation contours**

NOTE: Elevation contours are established on the drawing through the use of contour lines.

f. **Compass orientation**

NOTE: The surveyed property will be indicated by drawing a compass orientation commonly referred to as *bearings*. Bearings are measured in degrees as a reference from north or south. See Figure 1. Bearings do not normally exceed 90 degrees.

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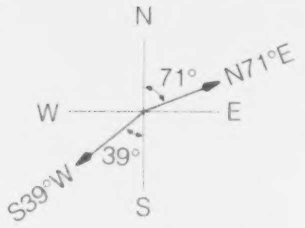
INFORMATION SHEET

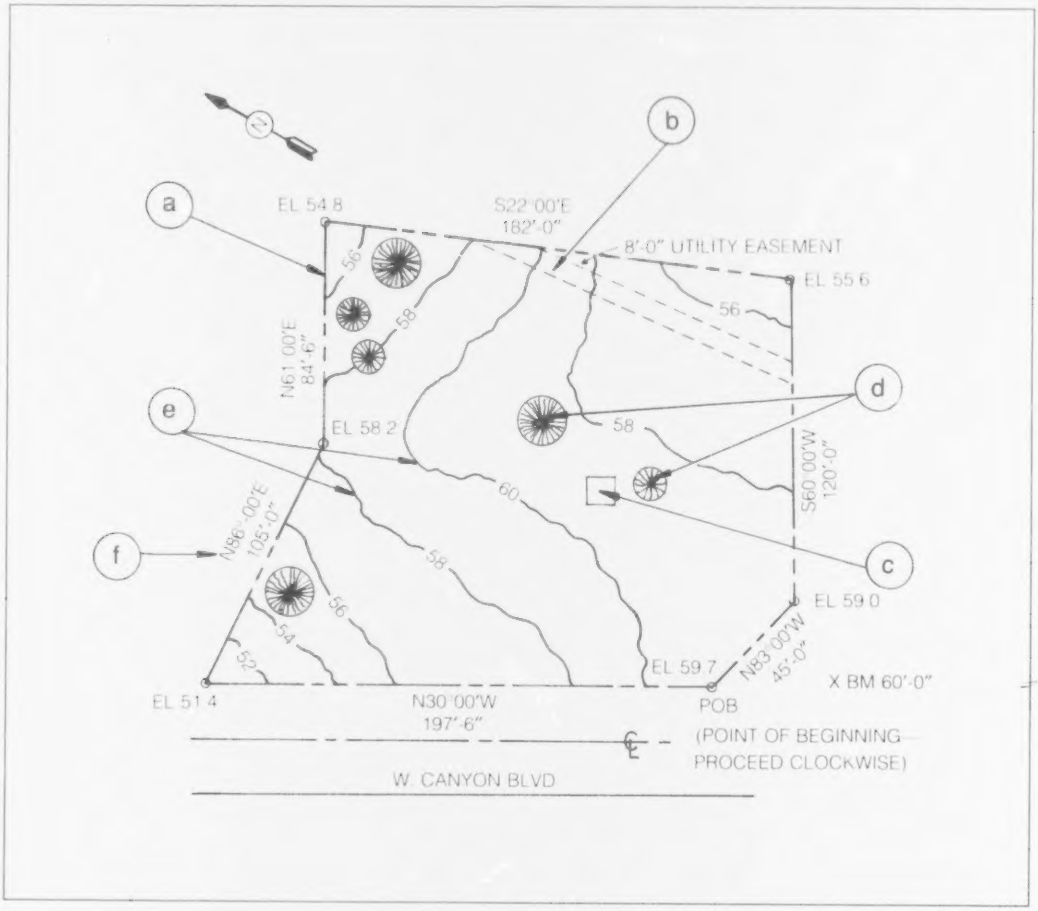
FIGURE 1


N
71°
N71°E
W
E
39°
S39°W
S

N71°E indicates a line measured 71° from north in an easterly direction.

S39°W indicates a line measured 39° from south in a westerly direction.

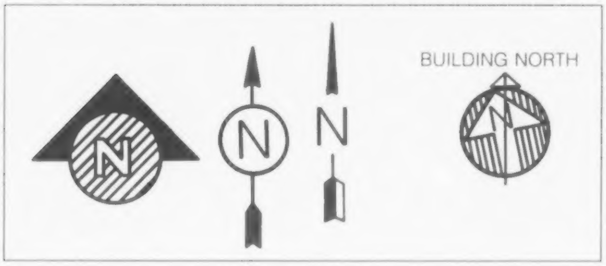
FIGURE 2: Property survey (site plan)


N
a
b
c
d
e
f
EL 54.8
S22°00'E
182'-0"
8'-0" UTILITY EASEMENT
EL 55.6
56
58
N61°00'E
84'-6"
EL 58.2
60
S60°00'W
120'-0"
N86°00'E
105'-0"
56
58
54
52
EL 59.0
N83°00'W
45'-0"
EL 59.7
X BM 60'-0"
EL 51.4
N30°00'W
197'-6"
POB
(POINT OF BEGINNING—
PROCEED CLOCKWISE)
℄
W. CANYON BLVD

INFORMATION SHEET

8. **Components of a plot plan** (see Figure 4)
   - a. **Length and bearing of each property line**
   - b. **Contour lines** (existing and proposed)
   - c. **Elevations of property corners, contour lines, and structure's finish floor**
   - d. **North arrow** (Figure 3)

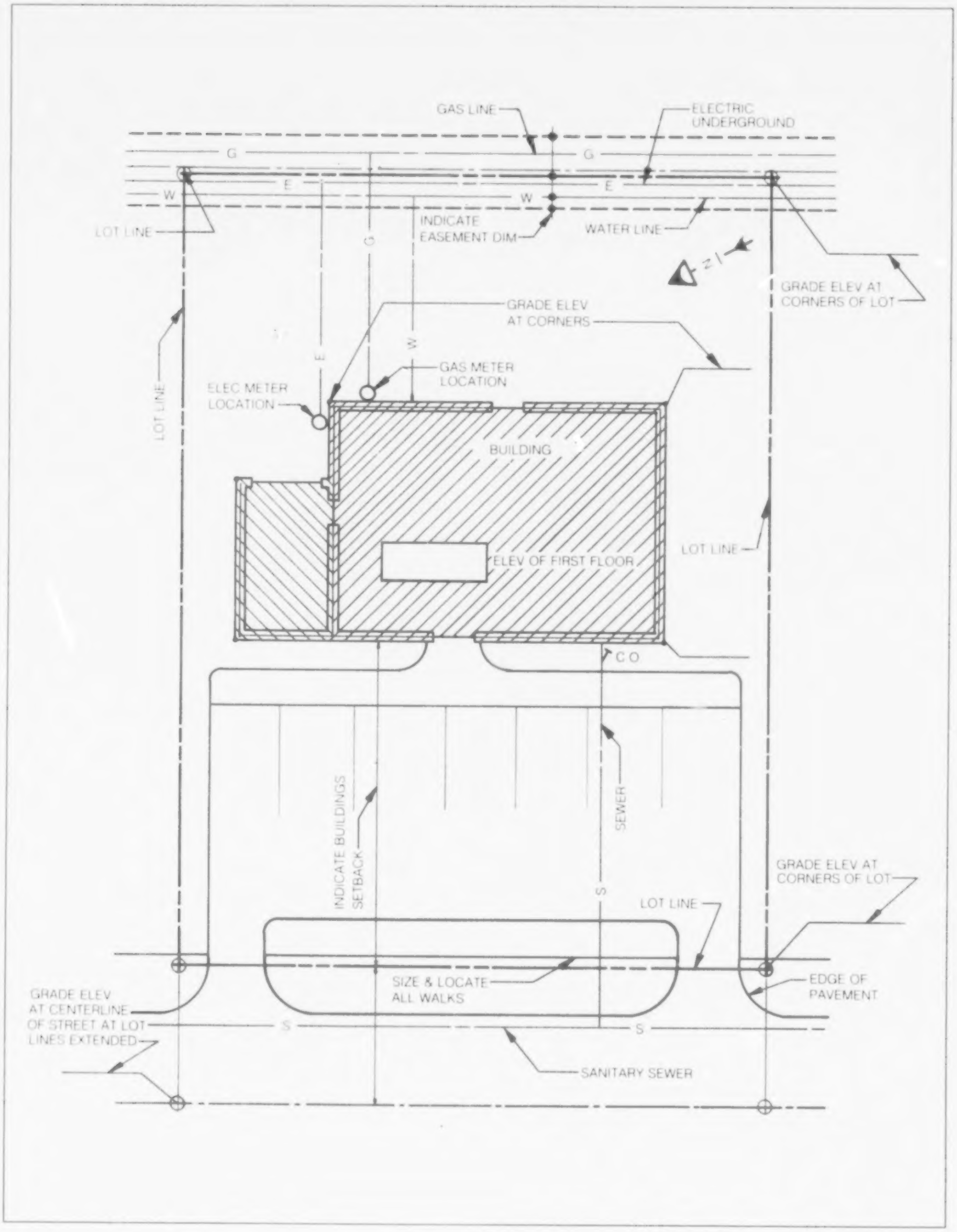
FIGURE 3



   - e. **Building lines**
   - f. **Location, outline, and dimensions of structures on site**
   - g. **Streets, driveways, parking areas, sidewalks, and medians**
   - h. **Location of utility lines**
   - i. **Location and width of easements**
   - j. **Fences and retaining walls**
   - k. **Legal description and address of site**
   - l. **Scale of drawing**

INFORMATION SHEET

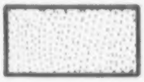
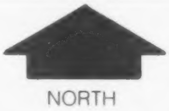
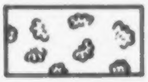
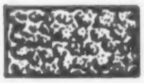
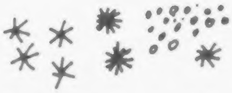
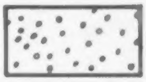
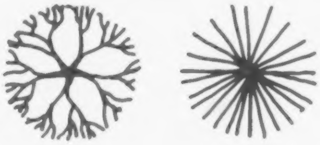
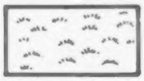
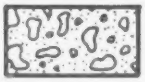
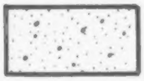
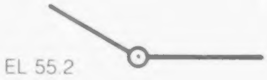
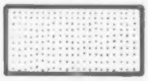
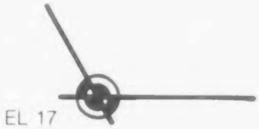
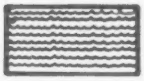
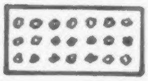
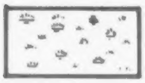
FIGURE 4: Plot plan


GAS LINE
ELECTRIC UNDERGROUND
G
G
E
E
W
W
LOT LINE
INDICATE EASEMENT DIM
WATER LINE
N
GRADE ELEV AT CORNERS OF LOT
GRADE ELEV AT CORNERS
G
E
W
GAS METER LOCATION
ELEC METER LOCATION
LOT LINE
BUILDING
ELEV OF FIRST FLOOR
LOT LINE
C O
SEWER
INDICATE BUILDINGS SETBACK
S
LOT LINE
GRADE ELEV AT CORNERS OF LOT
SIZE & LOCATE ALL WALKS
EDGE OF PAVEMENT
GRADE ELEV AT CENTERLINE OF STREET AT LOT LINES EXTENDED
S
S
SANITARY SEWER

INFORMATION SHEET

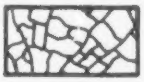
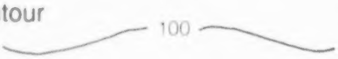
9. **Symbols commonly used on a plot plan** (Table 1)

TABLE 1

Sand		North arrow	
Open woodland		Well	
Dense forest		Ground cover	
Small irregularly spaced trees		Trees	
Tall grass		Spot elevation	+ EL 109.1
Large stones		Benchmarks	BM × 903.6 BM △ 675.4
Gravel		Property corner	
Cultivated area		Property corner with monument	
Water		Sanitary sewer	—— —— —— —— ——
Orchard		Gas line	——·——·——·——·——
Marsh		Water line	– – – – – – – – – – – –

INFORMATION SHEET

TABLE 1 (cont.)

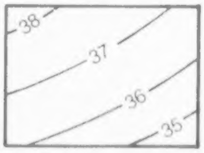
Dry cracked clay		Power line	.— — — . — — — . — — —
Unpaved road	= = = = = = =	Proposed contour	- - - - - - - -
Paved road	══════	Valley	———→
Railroad tracks	╫╫╫╫╫╫╫╫╫╫╫╫╫╫	Sewer tile	┼┼┼┼┼┼┼┼┼┼┼
Fence	X——X——X	Septic field	— — — — — —
Property line	—‑‑—‑‑—	Telephone	— — . — — . — —
Existing contour			

10. **Components of a grading plan and their definitions**

NOTE: Grading involves a redefining of the earth's surface to accommodate a building site. The amount of grading required will greatly determine the final cost and appearance of the site. The amount of grading required is shown by the development of a grading plan.

a. **Existing surveyed contours** (Figure 5)—Solid lines representing points of equal elevation and elevations representing a vertical distance above or below a referenced benchmark as surveyed on the initial site

FIGURE 5



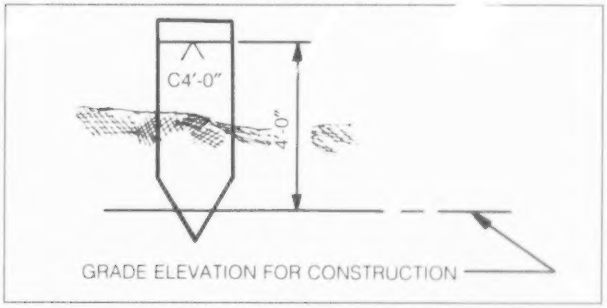
Existing contours

INFORMATION SHEET

b. **Proposed contours**—Dashed lines representing the appearance of the site after grading

c. **Cut and fill designations** (Figure 6)—Stake-like symbols with numerical indications representing the amount of earth to be removed from the existing site (cut) or added to the existing site (fill)

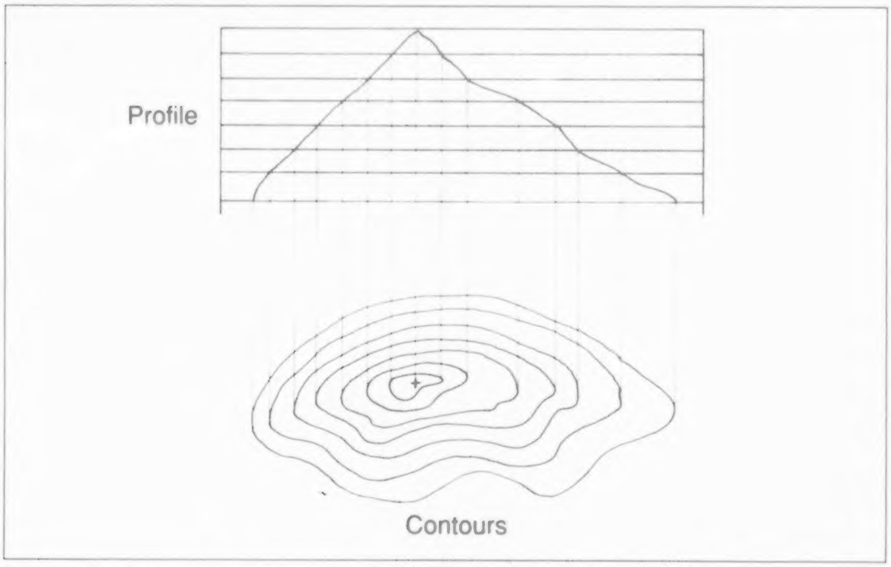
FIGURE 6: Cut designation



d. **Site profile** (Figure 7)—Drawing showing section view of site, as though the earth were cut vertically

NOTE: Many times a site profile will be drawn to better illustrate the changes in elevation on a site.

FIGURE 7: Site profile drawn from a contour map

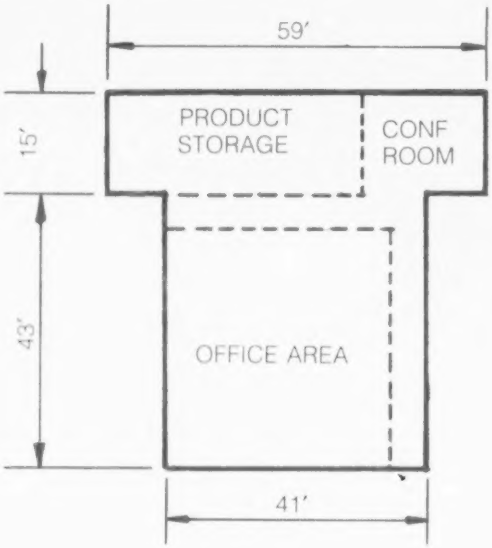


SITE CONDITIONS
UNIT 3

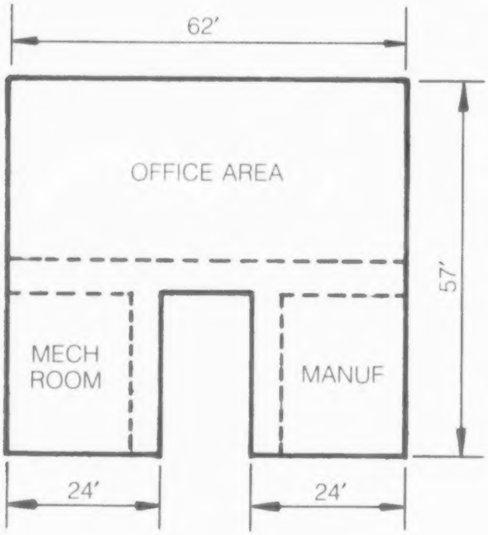
STUDENT SUPPLEMENT 1—ROUGH SKETCHES OF TWO COMMERCIAL BUILDINGS

The rough sketches of the two commercial buildings below will be used in completing Parts B and C of Assignment Sheet 1, "Analyze a Potential Construction Site." The sketches of these buildings have not been drawn to scale.

Building A


59′
15′
PRODUCT STORAGE
CONF ROOM
43′
OFFICE AREA
41′

Building B


62′
OFFICE AREA
57′
MECH ROOM
MANUF
24′
24′

SITE CONDITIONS
UNIT 3

STUDENT SUPPLEMENT 2—STEPS IN COMPLETING A PLOT PLAN

In Objective 8 of the information sheet, you learned the components of a plot plan. In Assignment Sheet 3, you will be required to draw a plot plan. By using the following steps as a checklist for completing your drawing, you will not only make sure that you have drawn all the required components but you will also complete the drawing in a logical order.

1. Select an appropriate scale (commonly 1″ = 20.0′ or larger).
2. Locate north arrow on drawing.
3. Lay out property lines.
4. Label bearing and length of each property line.
5. Select an appropriate contour interval.

   EXAMPLE: 5-foot interval; contours drawn at every 5-foot change in elevation
6. Determine location of any setback allowances or easements.
7. Locate building on the site.
8. Dimension overall length and width of building.
9. Draw surrounding features such as drives, sidewalks, parking areas, etc.
10. Determine location of necessary utilities.
11. Draw other remaining topographical features.
12. Letter legal description, site address, necessary notes, and title-block information.

SITE CONDITIONS
UNIT 3

STUDENT SUPPLEMENT 3—METHODS OF DESIGNATING CUT AND FILL REQUIREMENTS

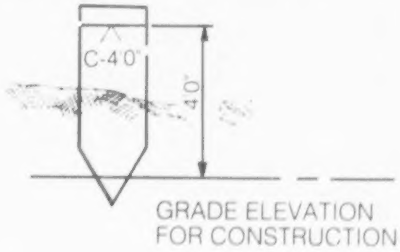
Cut and fill designations are required on a grading plan to indicate when earth must be either removed from the existing site (cut) or added to the existing site (fill) in order to accommodate construction of a particular structure. The two methods used for designating cut and fill requirements are outlined below. You will use the information presented below in completing Assignment Sheet 4, "Determine Required Cut and Fill Designations."

Designating cut requirements

If the elevation required during construction is below the grade mark, a cut (C) is indicated on the stake in the manner shown in the following illustration.

NOTE: The ∧ mark on the stake is referred to as a *keel.*

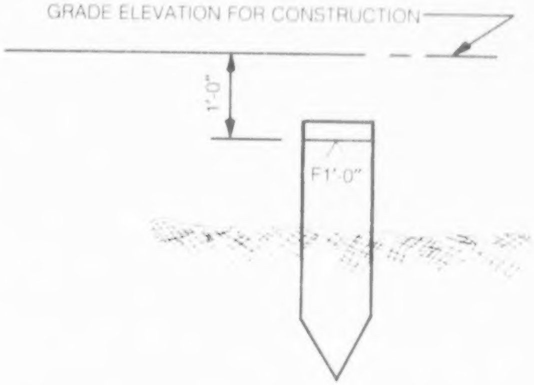
Cut indication



Designating fill requirements

If the elevation required during construction is above the grade mark, a fill (F) is indicated on the stake in the manner shown in the following illustration.

Fill indication



SITE CONDITIONS
UNIT 3

ASSIGNMENT SHEET 1—ANALYZE A POTENTIAL CONSTRUCTION SITE

Name ______________________ Score __________

Introduction

As a drafter, you should ask yourself a number of important questions about a site before it is selected for construction. You have studied these questions and several factors associated with site selection in Objectives 2 through 5 of the information sheet. In this assignment sheet, you will use those questions and analysis factors to conduct a site analysis of a commercial site in an area near your school.

Exercises

Part A

Rough sketch of commerical site

Directions

Locate a vacant site in a commercial area near your school and obtain as much information about the site as possible. Then, in the blank space below, draw a rough sketch of the site showing as many of the details about it as possible. Also indicate the site location on the blank lines provided below.

Site location ______________________

____

Sketch of commercial site

ASSIGNMENT SHEET 1

Part B **Write a site analysis**

Directions Study the rough sketches of the two commercial buildings (Building A and Building B) shown in Student Supplement 1. Then on the blank lines below, write an analysis of the considerations that should be made if these two buildings were to be constructed on the site you selected in Part A of this assignment. In your analysis, include as many of the factors from Objectives 2 through 5 of the information sheet as would apply.

ASSIGNMENT SHEET 1

Part C **Climate orientation**

Directions Climate orientation is a particularly critical factor in determining placement of a building on a construction site. Study the climate-orientation factors presented in Objective 3 of the information sheet, and on the blank lines provided below, describe the climate region you live in. Then in the space provided below, draw a rough sketch orienting Building A and Building B in Student Supplement 1 on the commercial site you selected in Part A of this assignment. Use a scale of 1" = 20.0'.

Description of the climate factors in your area ____________

____

____

____

____

____

Rough sketch orienting Building A and Building B on the site you selected in Part A

SITE CONDITIONS
UNIT 3

ASSIGNMENT SHEET 2—DRAW A PROPERTY SURVEY

Name ______________________________ Score ______________

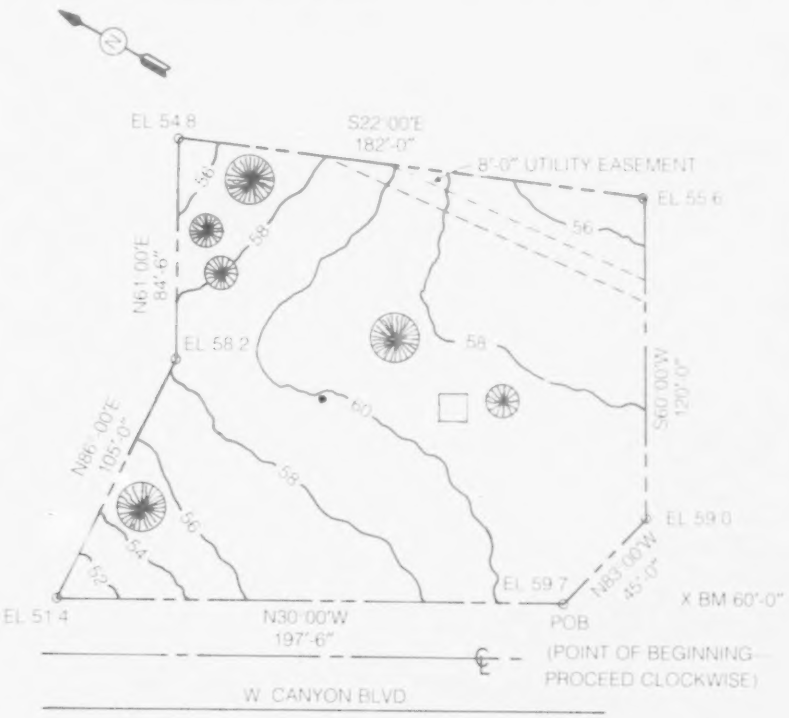
Introduction

As you have learned in Objective 6 of the information sheet, a property survey (sometimes called a *site plan*) is one of the drawings a drafter is often required to complete as a part of a site analysis. Property surveys are drawings that show the legal boundaries, elevations, topography, and man-made features of a site. The development of an accurate property survey is so important because this drawing becomes the basis of other types of drawings done as a part of a site analysis. In this assignment sheet, you will practice drawing a property survey.

Exercise

Directions

Using a sheet of size-C vellum, draw the property survey shown below. Use a scale of 1" = 20.0' in completing the drawing. Indicate the contour lines by approximation and assign a lot number and location to the site.


N
EL 54.8
S22°00'E
182'-0"
8'-0" UTILITY EASEMENT
EL 55.6
56
56
58
N61°00'E
84'-6"
EL 58.2
58
60
S60°00'W
120'-0"
N86°00'E
105'-0"
58
56
54
52
EL 59.0
EL 59.7
N83°00'W
45'-0"
X BM 60'-0"
EL 51.4
N30°00'W
197'-6"
POB
(POINT OF BEGINNING—
PROCEED CLOCKWISE)
℄
W. CANYON BLVD

BEST COPY AVAILABLE

SITE CONDITIONS
UNIT 3

ASSIGNMENT SHEET 3—DRAW A PLOT PLAN

Name ______________________________ Score ____________

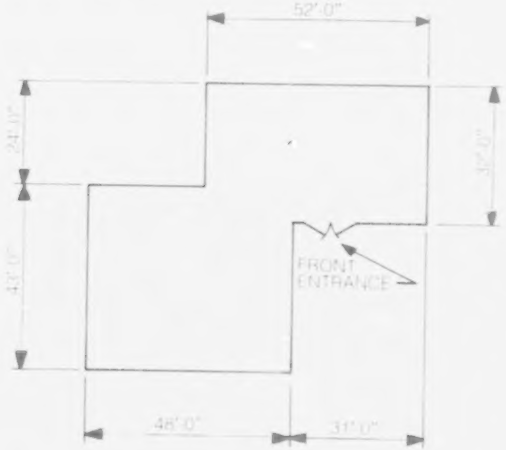
Introduction As you have learned in Objective 6 of the information sheet, the primary function of a plot plan is to locate buildings, utilities, roads, sidewalks, parking areas, and other construction features on an existing site. In Objectives 8 and 9, you also learned the components of a plot plan and the symbols commonly used on plot plans. This assignment sheet and Student Supplement 2, "Steps in Completing a Plot Plan," are designed to help you apply this information in learning to draw a plot plan.

Exercise

Directions Read Student Supplement 2 and then using the information from the sketch of the office building shown below, locate the office building on the property survey you completed for the site in Assignment Sheet 2.

Indicate utility lines (gas, water, electric) running from the street to the west side of the building, and draw a 4′-0″ sidewalk around the perimeter of the building. Indicate an 18′-0″-wide entrance drive off of the street running to a 30′-0″-square parking area in front of the office building.

Sketch of office building



SITE CONDITIONS
UNIT 3

ASSIGNMENT SHEET 4—DETERMINE REQUIRED CUT AND FILL DESIGNATIONS

Name ______________________________ Score ____________

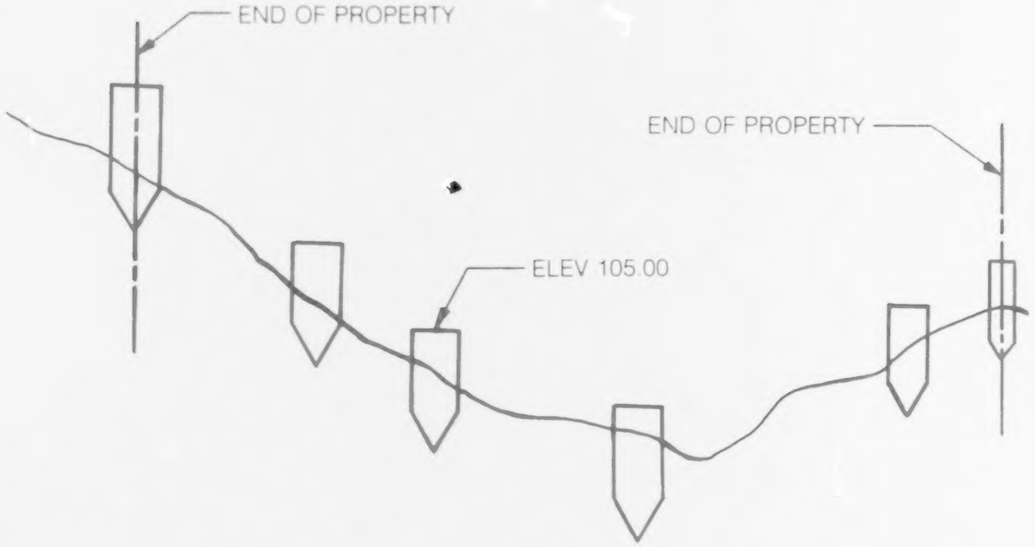
Introduction The architectural drafter needs to have the ability to read cut and fill designations in order to produce a technically correct drawing. This assignment sheet will require the student to read and determine cut and fill designations based upon given information.

Exercise

Directions A site needs to be made level at the elevation given below. Using this elevation, the scale also given below, and the methods demonstrated in Student Supplement 3, indicate on each of the stakes in the illustration whether cut (C) or fill (F) is needed and the amount of cut or fill required.

Elevation: 107.0

Scale: Vertical—¼" = 1'-0"
Horizontal—1/16" = 1'-0"



SITE CONDITIONS
UNIT 3

WRITTEN TEST

Name ______________________________ Score ____________

1. Match terms associated with site conditions to their correct definitions. Write the numbers on the blanks provided.

_____a. Instrument that is evidence of ownership

_____b. Charge placed upon property until some debt is satisfied

_____c. Established line on a property beyond which a structure may not extend

_____d. Permanent reference point of known elevation from which other points can be measured

_____e. Vertical distance measured above or below an established reference point

_____f. Upper limit of the portion of the ground that is saturated with water

_____g. Line on a drawing representing points of equal elevation

_____h. Height of finish floor upon completion of structure

_____i. Building location

1. Benchmark
2. Building line
3. Contour line
4. Elevation
5. Finish-floor elevation
6. Lien
7. Site
8. Title
9. Water table

2. Discuss general questions considered in conducting a site analysis. Write your answers on the blanks provided with each of the items below.

a. Functional adequacy of site ______________________________

____

____

____

____

WRITTEN TEST

b. Cost of site

c. Site adaptability

d. Site accessibility

e. Site's availability to adequate utilities

f. Clear title

WRITTEN TEST

g. Zoning regulations ____________________

h. Easements and setback allowances ____________________

3. Describe climate-orientation factors considered in conducting a site analysis. Write your answers on the blanks provided with each factor below.

   a. Prevailing-wind considerations ____________________

WRITTEN TEST

b. Thermal-radiation considerations ______________________________

4. Match physical characteristics of a site considered in conducting a site analysis to their correct definitions. Write the numbers on the blanks provided.

_____a. Depressions in the ground often designed for channeling surface water around a structure

_____b. Man-made ditches used to divert water runoff and minimize water flow to help prevent soil erosion

_____c. Concrete, brick, or railroad-tie walls built to hold earth on steep slopes

_____d. Continuous embankments of earth that help control flooding and soil erosion during heavy rains and help reduce noise from outside sources

_____e. Upward or downward slant of land, or inclination or degree of that slant

_____f. Water basins that prevent soil sediment from entering sewers and/or waterways

1. Slope
2. Swales
3. Channels
4. Sediment ponds
5. Earth berms
6. Retaining walls

WRITTEN TEST

5. Match site-clearing and removal practices considered when conducting a site analysis to their correct definitions. Write the numbers on the blanks provided.

______a. Felling trees or removing topographical features that would interfere with construction on the site

______b. Hauling away unwanted materials

______c. Rescuing from wreckage certain materials of future value

______d. Smashing natural or man-made obstacles by blasting, wrecking, or using hand tools such as crowbars and saws

______e. Destroying obstacles through the use of a controlled fire

1. Demolishing
2. Salvaging
3. Cutting
4. Burning
5. Disposing

6. Define types of drawings commonly completed as a part of a site analysis. Write your definitions on the blanks provided with each of the items below.

a. Property survey ____

____

____

____

____

b. Plot plan ____

____

____

____

____

c. Grading plan ____

____

____

____

____

WRITTEN TEST

7. Identify components of the property survey shown in the illustration below. Write your answers on the blanks provided below.

Legal boundary	**Easement**
Topographical features	**Elevation contours**
Existing man-made entity	**Compass orientation**

a. ____________________

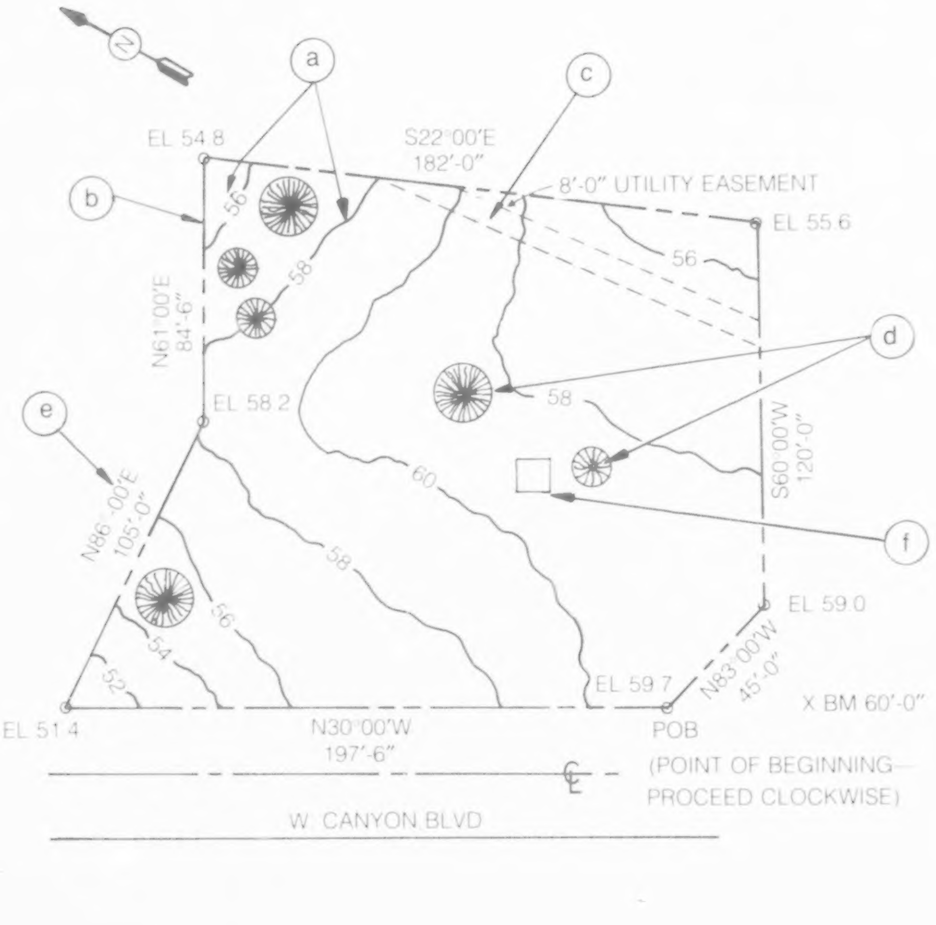
b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________


N
a
b
c
d
e
f
EL 54.8
S22°00'E
182'-0"
8'-0" UTILITY EASEMENT
EL 55.6
56
58
60
58
56
54
52
56
58
N61°00'E
84'-6"
EL 58.2
N86°-00'E
105'-0"
S60°00'W
120'-0"
EL 59.0
N83°00'W
45'-0"
EL 59.7
X BM 60'-0"
EL 51.4
N30°00'W
197'-6"
POB
(POINT OF BEGINNING—PROCEED CLOCKWISE)
℄
W. CANYON BLVD

WRITTEN TEST

8. List 8 of the 12 components of a plot plan. Write your answers on the blanks below.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

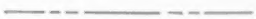
e. ______________________________

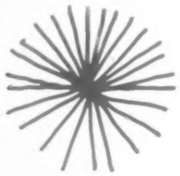
f. ______________________________

g. ______________________________

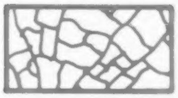
h. ______________________________

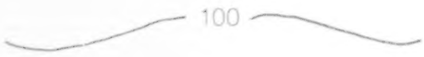
9. Label symbols commonly used on a plot plan. Write your answers on the blanks provided under each of the following symbols.



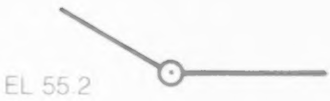


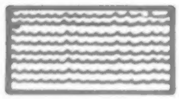
a. ____________________ b. ____________________





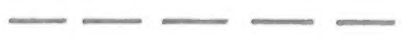
c. ____________________ d. ____________________

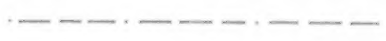




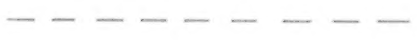
e. ____________________ f. ____________________

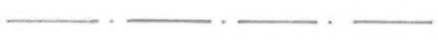
WRITTEN TEST



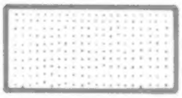


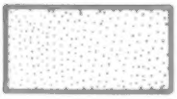
g. ______________________________ h. ______________________________



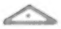


i. ______________________________ j. ______________________________



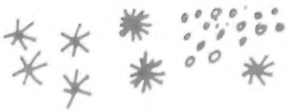


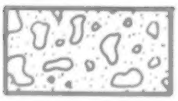
k. ______________________________ l. ______________________________

BM  675.4

+ EL 109.1

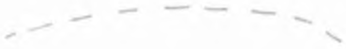
m. ______________________________ n. ______________________________





o. ______________________________ p. ______________________________

WRITTEN TEST



q. ______________________ r. ______________________

10. Match components of a grading plan to their correct definitions. Write the numbers on the blanks provided.

_____a. Stake-like symbols with numerical indications representing the amount of earth to be removed from the existing site or added to the existing site

_____b. Solid lines representing points of equal elevation and elevations representing a vertical distance above or below a referenced benchmark as surveyed on the initial site

_____c. Dashed lines representing the appearance of the site after grading

_____d. Drawing showing section view of site, as though the earth were cut vertically

1. Existing surveyed contours
2. Proposed contours
3. Cut and fill designations
4. Site profile

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INTRODUCTION TO WORKING DRAWINGS
UNIT 4

UNIT OBJECTIVE

After completing this unit, the student should be able to identify reference methods and symbols and develop an architectural floor plan and corresponding elevation views. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with working drawings to their correct definitions.
2. Describe types of drawings usually included in a set of working drawings.
3. Match types of drawings in a set of working drawings to descriptions of the information found on those drawings.
4. Arrange in order the standard sequence of drawings in a set of working drawings.
5. Describe the drawing-identification system used in a set of working drawings.
6. Label the components of a title block.
7. Identify standard architectural-linework techniques.
8. Label plan symbols used on floor plans.
9. Label plan symbols used on elevation drawings.
10. Identify symbols and methods used in cross-referencing drawings.
11. Label standard headings presented in drawing schedules.
12. Prepare a title block. (Assignment Sheet 1)
13. Determine appropriate drawing scales. (Assignment Sheet 2)
14. Develop a floor plan. (Assignment Sheet 3)
15. Develop elevation drawings. (Assignment Sheet 4)

INTRODUCTION TO WORKING DRAWINGS
UNIT 4

SUGGESTED ACTIVITIES

Preparation

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery and Application" section and plan classroom activities. Also note suggestions for media and supplemenal materials.

- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section.
- Make transparencies from the transparency masters included in this unit.
- Prepare classroom and lab. Put up posters, charts, and signs; display articles and other references related to the objectives of this unit.

Delivery and Application

Unit introduction

- Provide students with objective sheet. Discuss unit and specific objectives.
- Show students the sample set of working drawings included with the teacher edition of this publication. Explain how the drawing sheets are interrelated and the purposeful arrangement of the various sheets.
- Hold a class discussion examining why working drawings are so important, who uses them and why, and how the architect/drafter must work with various groups, agencies, engineers, and contractors to develop a complete set of drawings.
- Provide students with the information sheet.

Objective 1 Match terms associated with working drawings to their correct definitions.

- Show students examples of perspective, mechanical, and structural drawings when discussing these terms. Use the sample set of drawings included with the teacher edition to illustrate your discussion.

SUGGESTED ACTIVITIES

Objective 2 Describe types of drawings usually included in a set of working drawings.

- Have students refer to the sample set of drawings included with the teacher edition, which includes the types of drawings discussed in this objective. Refer to sample drawings when discussing the descriptions given.
- Stress to students the importance of the floor plan. Read to students the note following the floor-plan item in the objective.

Objective 3 Match types of drawings in a set of working drawings to descriptions of the information found on those drawings.

- Discuss with students the information provided in the objective, again using the plans provided in the sample set of drawings to illustrate your discussion.
- Stress to students the note accompanying the discussion of a detail drawing. All of the items listed under this part of the objective would never appear on a single detail drawing. This list includes all items that could appear as a detail drawing. Show various samples of specific detail drawings.

Objective 4 Arrange in order the standard sequence of drawings in a set of working drawings.

- Read to students the note introducing this objective, and then discuss the typical packaging of a set of drawings. Show various examples of working-drawing sets (from simple to complex) and note the similarities of the packaging of them all. Refer also to the sample set of drawings included in the teacher edition.
- List a series of drawings on the board and have the class arrange the drawings in the standard sequence.

Objective 5 Describe the drawing-identification system used in a set of working drawings.

- Read with students the explanation given in the objective. List on the board a series of drawings that might appear in a section of the working drawings (i.e., mechanical) and then have the class assign an alphanumeric callout to each sheet listed.

SUGGESTED ACTIVITIES

Objective 6 Label the components of a title block.

- Read to students the note that introduces the objective. Emphasize to students that these are the minimum components required on a title block. Use Transparency 1, "Minimum Components Required on a Title Block," and the artwork provided in the information sheet to illustrate your discussion.
- Show students examples of title blocks from various companies, discussing their consistent similarities as well as unique qualities. Also discuss the use of space, design, and implementation of logos within the title block.
- Hand out Assignment Sheet 1, "Prepare a Title Block." Read the introduction and directions to the assignment and answer student questions. Challenge students' creativity by making a competition of the creation of a title block for their school. Have students complete Assignment Sheet 1.

Objective 7 Identify standard architectural-linework techniques.

- Read with students the information presented in the objective concerning line-weight contrast and various line types. Referring to the sample set of drawings included with the teacher edition, emphasize that, unlike engineering drawings, architectural drawings tend to be very crowded with information; therefore, these techniques are very important.
- Have students draw a simple floor plan, using the engineering-linework method. Then discuss the architectural-linework method and have students redraw the floor plan using this method. Discuss the results of this demonstration.

Objective 8 Label plan symbols used on floor plans.

- Draw on the chalkboard each of the symbols presented in the objective. Discuss the meaning of each symbol and the procedure for drawing it.
- Show the film *Architectural Drafting—Plan Symbols and Exterior Walls.*

Objective 9 Label plan symbols used on elevation drawings.

- Draw on the chalkboard each of the symbols presented in the objective. Discuss the meaning of each symbol and the procedure for drawing it.
- Explain that some symbols are drawn differently on different types of drawings. Show, for example, how certain symbols vary when used on section and elevation drawings.

SUGGESTED ACTIVITIES

Objective 10 Identify symbols and methods used in cross-referencing drawings.

- Read to students the note introducing the objective, and then stress the importance of being able to accurately cross-reference various drawing sheets. Use examples from completed sets of working drawings (see the sample set of drawings included with the teacher edition) or the drawings in Transparencies 2 and 3, "Use of Cross-Referencing Symbols and Methods." Have students identify the common reference symbols found on those drawings.

- Discuss the flexibility of using different geometric shapes for schedule symbols. Show examples of reference-symbol use on various plans.

Objective 11 Label standard headings presented in drawing schedules.

- Using Transparencies 4 through 9, discuss each type of drawing schedule and the standard headings used on the schedules. Highlight use of reference symbols used to identify various components (i.e., doors, windows, light fixtures).

- Explain the importance of using schedules for estimating material costs and purchasing.

Assignment Sheets 2 through 4

- Read the introduction to Assignment Sheet 2, "Determine Appropriate Drawing Scales." Then further explain the importance of selecting a suitable scale for a drawing. Also discuss methods of how to center a drawing on the paper and how to mathematically calculate how much space a particular layout will occupy.

  Discuss the importance of maintaining a selected scale on as many different drawings as possible in order to permit projection and overlay methods to be used.

  Discuss the directions to both Part A and Part B of the assignment and answer student questions. Have students complete Assignment Sheet 2.

- Read the introduction to Assignment Sheet 3, "Develop a Floor Plan." Explain the importance of accuracy in developing a floor plan.

SUGGESTED ACTIVITIES

Discuss the general drawing sequence for developing a floor plan, then show the films *Architectural Drafting—Interior Partitions and Doors* and *Architectural Drafting—Broadening the Object Lines*.

Review the use of standard reference materials (Unit 1) in developing the assignment floor plan with adequate room sizes, minimum number of bathrooms, minimum hallway widths, etc.

After a complete discussion of the scenario included in the assignment, have students complete Assignment Sheet 3.

- Read the introduction to Assignment Sheet 4, "Develop Elevation Drawings." Discuss and show examples of the two types of elevation drawings, noting the methods used to create a pictorial representation (i.e., symbology and a great amount of detail to doors and windows).

  Discuss the drawing procedure for developing elevation drawings and explain the two methods of labeling elevation views.

  Read with students the directions to the assignment and explain the elevation information given. Have students complete Assignment Sheet 4.

Evaluation

- Give written test.
- Compile written-test and assignment-sheet scores on Unit Evaluation Form.
- Reteach and retest as required.

Suggested Resources

Resources used in developing unit

Print media

- Helper, D. E., and Paul Wallach. *Architecture: Drafting and Design*. New York: McGraw-Hill, 1987.
- Muller, Edward J. *Architectural Drawing and Light Construction*. Englewood Cliffs, New Jersey: Prentice-Hall, 1985.
- Spence, William P. *Architecture: Design, Engineering, Drawing*. Bloomington, Illinois: Glencoe, Bennett, and McKnight, 1985.

SUGGESTED ACTIVITIES

Additional resources

Media

- *Architectural Drafting—Broadening the Object Lines.* Copyright 1988, available on VHS, 10 minutes. Bergwall Productions, Inc., P.O. Box 238, Garden City, New York 11530-0238.

  Included in this video is an explanation of various line weights as well as a demonstration of the methods used in completing door and window symbols by adding door swings and glass lines.

- *Architectural Drafting—Interior Partitions and Doors.* Copyright 1988, available on VHS, 12 minutes. Bergwall Productions, Inc., P.O. Box 238, Garden City, New York 11530-0238.

  This videotape discusses door types, door construction, and the development of a door schedule. In addition, placement of interior partition walls on a floor plan are examined.

- *Architectural Drafting—Plan Symbols and Exterior Walls.* Copyright 1988, available on VHS, 10 minutes. Bergwall Productions, Inc., P.O. Box 238, Garden City, New York 11530-0238.

  This videotape uses a model house to explain floor plans, examines types of wall constructions, and describes plan symbols.

Print media

- Lewis, Jack R. *Architectural Draftsman's Reference Handbook.* Englewood Cliffs, New Jersey: Prentice-Hall, 1982.

- Ramsey, Charles. *Architectural Graphic Standards*, 8th ed. New York: Wiley and Sons, 1988.

INTRODUCTION TO WORKING DRAWINGS
UNIT 4

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1	Evaluated to the satisfaction of the instructor.
Assignment Sheet 2	Evaluated to the satisfaction of the instructor.
Assignment Sheet 3	Evaluated to the satisfaction of the instructor.
Assignment Sheet 4	Evaluated to the satisfaction of the instructor.

INTRODUCTION TO WORKING DRAWINGS
UNIT 4

ANSWERS TO WRITTEN TEST

1. a. 4
   b. 3
   c. 6
   d. 2
   e. 5
   f. 1
   g. 8
   h. 9
   i. 10
   j. 7

2. a. Horizontal view showing where structure is to be located on a site
   b. Horizontal view of entire substructure below first floor or frame of structure
   c. Horizontal view of structure, showing length and breadth of structure and layout of rooms on that floor
   d. Vertical two-dimensional view showing shape and design of each of the exterior or interior faces of a structure
   e. Cut-away view through an object or wall to show its interior makeup
   f. Large-scale graphic of part of another drawing, indicating special features of design, location, and composition and the correlation of the elements and materials shown
   g. Floor plan with electrical symbols showing exact location of switches, outlets, and electrical devices to accommodate appliances and fixtures; also lines that represent wiring from each switch to the connecting fixture
   h. Floor plan with heating, ventilating, and air-conditioning symbols showing location and types of equipment, movement of hot and cold air, and location and size of ducts and diffusers
   i. Floor plan with symbols representing location and types of fixtures, vents, valves, and pipe that will be installed in the structure

3. a. 2
   b. 6
   c. 1
   d. 4
   e. 3
   f. 5

4. a. 2
   b. 4
   c. 3
   d. 1
   e. 5

5. a. Drawing-identification system consists of an alphanumeric callout placed on the title block located on each drawing
   b. The letter in the callout relates directly to the type of drawing shown on the sheet
   c. The number in the callout indicates the sequence of the sheet within the section where the drawing appears
   d. Therefore, architectural-drawing callouts are numbered A1, A2, A3, etc.; structural-drawing callouts are numbered S1, S2, S3, etc.; mechanical-drawing callouts are numbered M1, M2, M3, etc.; and electrical-drawing callouts are numbered E1, E2, E3, etc.

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ANSWERS TO WRITTEN TEST

6. a. Client's name
   b. Site address
   c. Checked by
   d. Sheet number
   e. Date drawing was completed
   f. Project number
   g. Scale of drawing
   h. Approved by
   i. Drafter's name or initials
   j. Title of sheet
   k. Architectural firm's name

7. a. 2
   b. 3
   c. 3

8. a. Concrete
   b. Wood
   c. Bathroom fixtures
   d. Window
   e. Brick
   f. Door
   g. Stairway
   h. Metal stud to drywall

9. a. Horizontal wood siding
   b. Cut stone
   c. Earth
   d. Glass
   e. Rock
   f. Concrete block
   g. Vertical wood siding
   h. Concrete
   i. Wood shingle
   j. Stucco
   k. Brick

10. a. Match-line method
    b. Schedule symbols
    c. Key-plan method
    d. Plan-grid method
    e. Datum-target symbol

11. a. Column and beam schedule

    (1) Number identifying type of column or beam referenced
    (2) Number indicating quantity required of column or beam referenced
    (3) Description of column or beam referenced; lists size, type, and material to be used in constructing column or beam
    (4) Length of column or beam referenced
    (5) Any further information that may be needed about column or beam referenced

    b. Window schedule

    (1) Symbol used for type of window referenced
    (2) Dimensions of window referenced
    (3) Type of window referenced
    (4) Manufacturer's name and catalog number of window referenced
    (5) Further description of window referenced
    (6) Type of glazing to be used on window referenced

ANSWERS TO WRITTEN TEST

c. Footing schedule

(1) Number identifying footing referenced on drawing
(2) "A" dimension of footing referenced on drawing
(3) "B" dimension of footing referenced on drawing
(4) "C" dimension of footing referenced on drawing
(5) Elevation of footing referenced
(6) Size and quantity of any reinforcement bars required for footing referenced
(7) Any further information that may be needed for footing referenced

d. Electrical schedule

(1) Type of room where electrical fixture referenced is to be installed
(2) Graphic symbol for type of electrical fixture referenced
(3) Quantity required for electrical fixture referenced
(4) Watts or amperage required for electrical fixture referenced
(5) Description of type of electrical fixture referenced
(6) Name of manufacturer and catalog number of electrical fixture referenced

e. Door schedule

(1) Symbol used for type of door referenced
(2) Dimensions of door referenced
(3) Manufacturer's name and catalog number of door referenced
(4) Further description of door referenced
(5) Material to be used in the manufacture of door referenced
(6) Thickness of door referenced
(7) Type of door referenced

f. Room finish schedule

(1) Number identifying room referenced
(2) Type of room referenced
(3) Reference callout for type of floor to be used in room referenced
(4) Reference callout for type of base to be used in room referenced
(5) Material and finish callout for each wall in room referenced
(6) Material and finish callouts and height of ceiling in room referenced
(7) Materials listing and reference numbers used in schedule
(8) Paint and finish listing and reference numbers used in schedule

INTRODUCTION TO WORKING DRAWINGS
UNIT 4

UNIT EVALUATION FORM

Student name ______________________ Unit rating __________

Assignment sheet ratings

Assignment Sheet 1—Prepare a Title Block Rating __________

Comments: ______________________

____

Assignment Sheet 2—Determine Appropriate Drawing Scales Rating __________

Comments: ______________________

____

Assignment Sheet 3—Develop a Floor Plan Rating __________

Comments: ______________________

____

Assignment Sheet 4—Develop Elevation Drawings Rating __________

Comments: ______________________

____

Written test scores

Pretest __________ Other __________

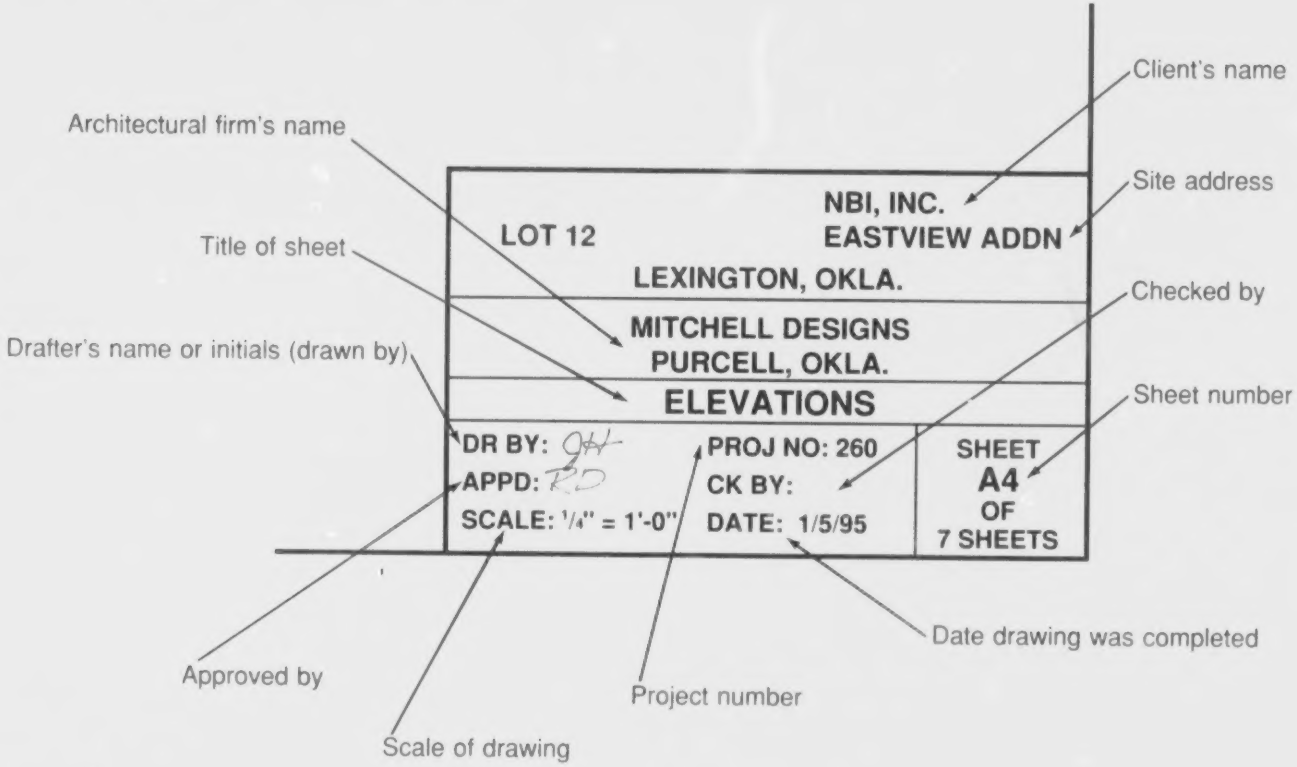
Posttest __________

Instructor signature ______________________ Date __________

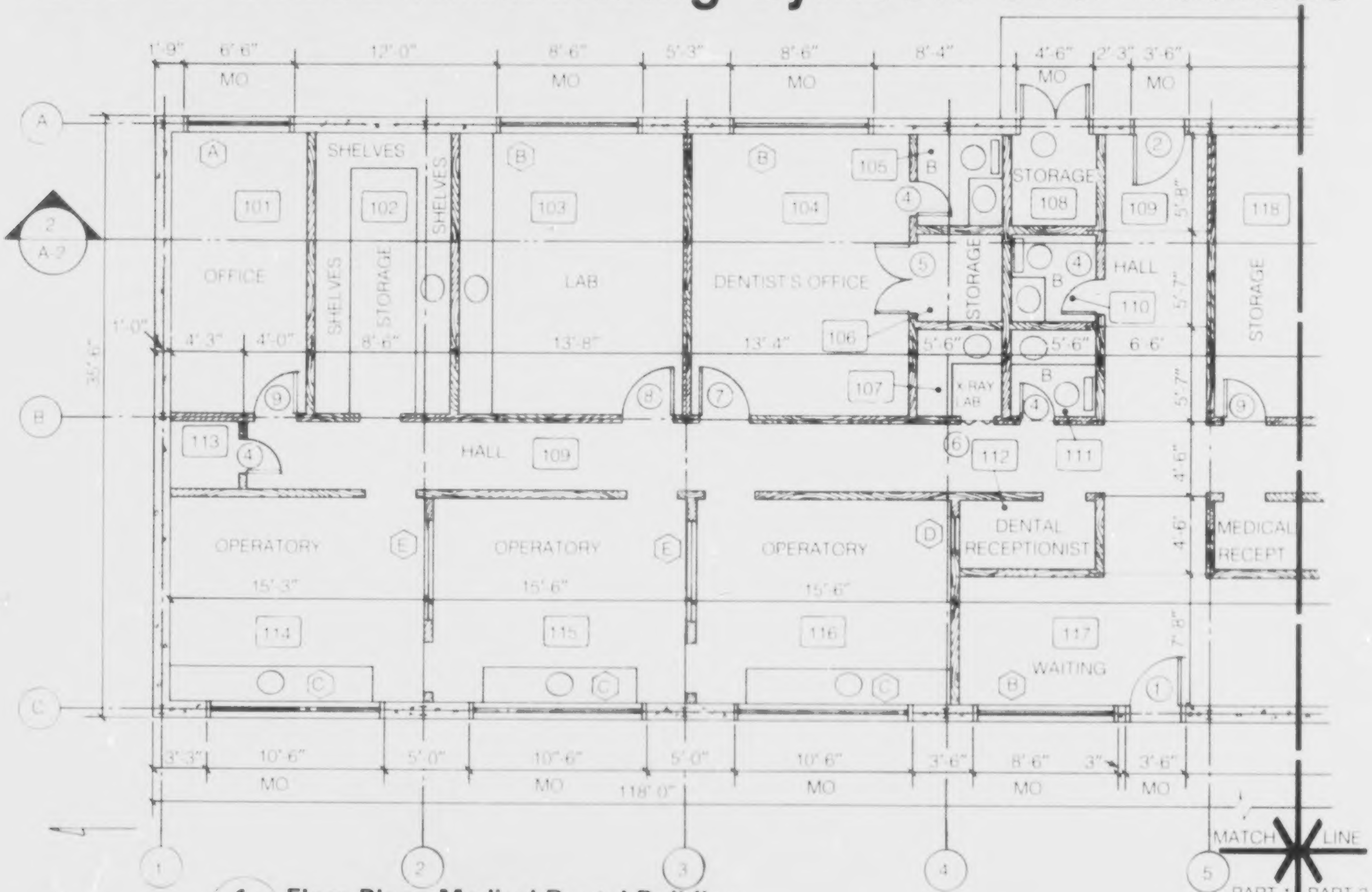
Student signature ______________________ Date __________

Duplication of this form is permitted.

Minimum Components Required on a Title Block


Client's name
Architectural firm's name
Site address
NBI, INC.
LOT 12
EASTVIEW ADDN
Title of sheet
LEXINGTON, OKLA.
Checked by
MITCHELL DESIGNS
Drafter's name or initials (drawn by)
PURCELL, OKLA.
ELEVATIONS
Sheet number
DR BY: JH
PROJ NO: 260
SHEET
APPD: RD
CK BY:
A4
OF
SCALE: ¼" = 1'-0"
DATE: 1/5/95
7 SHEETS
Date drawing was completed
Approved by
Project number
Scale of drawing

Use of Cross-Referencing Symbols and Methods


1'-9"
6'-6"
12'-0"
8'-6"
5'-3"
8'-6"
8'-4"
4'-6"
2'-3"
3'-6"
MO
A
B
C
2
A-2
1'-0"
36'-6"
4'-3"
4'-0"
8'-6"
13'-8"
13'-4"
5'-6"
6'-6"
5'-8"
5'-7"
4'-6"
7'-8"
SHELVES
STORAGE
OFFICE
LAB
DENTIST'S OFFICE
X-RAY LAB
HALL
MEDICAL RECEPT
DENTAL RECEPTIONIST
OPERATORY
WAITING
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
D
E
15'-3"
15'-6"
3'-3"
10'-6"
5'-0"
3'-6"
8'-6"
3"
118'-0"
1
2
3
4
5
9
8
7
6
MATCH LINE
PART 1
PART 2

1 / A-1 **Floor Plan - Medical Dental Building**
Scale: 1/8" = 1'-0"

TM 2

AD-209

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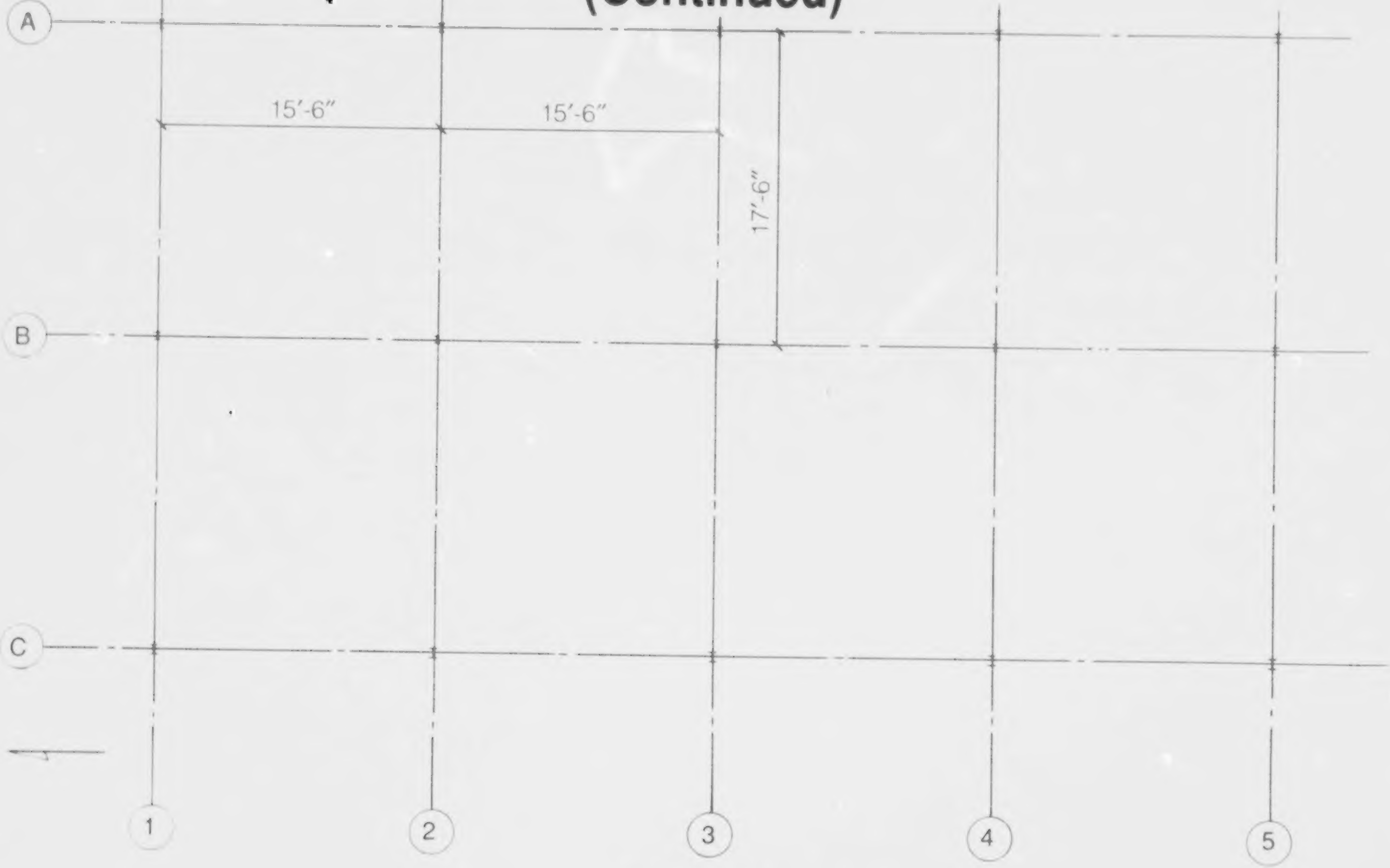
Use of Cross-Referencing Symbols and Methods
(Continued)


A
B
C
15'-6"
15'-6"
17'-6"
1
2
3
4
5

Grid System

Window Schedule

①	②	③	④	⑤	⑥
Sym	**Size**	**Type**	**Mfgr & catalog no**	**Remarks**	**Glass**
A	6′-0″ × 4′-0″	Fixed	"E-Z set" 7248C	Alum w/plastic screens	Thermopane
B	8′-0″ × 4′-0″	DO	DO 9648C	DO	DO
C	10′-0″ × 3′-0″	DO	DO 12036C	DO	DO
D	2′-0″ × 4′-0″	DO	DO 2448M	Wood trim	¼″ PP
E	6′-0″ × 4′-0″	DO	DO 7248M	DO	DO
F	7′-0″ × 4′-0″	DO	DO 8448C	Alum w/plastic screens	Thermopane
G	6′-0″ × 3′-0″	DO	DO 7236C		DO

Door Schedule

①	②		③	④	⑤	⑥	⑦
Sym	**Size**	**Mfgr & catalog no**		**Remarks**	**Material**	**Thk**	**Type**
1	3′-0″ × 6′-8″	Phillips	Housemart	3 coats ext trim paint	Metal	1¾″	Solid
2	3′-0″ × 6′-8″	DO	M-1 M-5	DO	DO	DO	DO
3	2′-0″ × 6′-8″	DO	M-91	DO	DO	DO	DO
4	2′-0″ × 6′-8″	DO	A-4	Stain & lacq finish	Birch	1⅜″	Hollow core
5	2′-0″ × 6′-8″	DO	A-10	DO	DO	DO	DO
6	2′-0″ × 6′-8″	DO	B-17	DO	Pine	DO	Bifold
7	3′-0″ × 6′-8″	DO	A-5	DO	Birch	DO	Solid core
8	3′-0″ × 6′-8″	DO	A-17	DO	DO	DO	Hollow core
9	2′-6″ × 6′-8″	DO	A-21	DO	DO	DO	DO
10	2′-10″ × 6′-8″	DO	D-7	DO	DO	DO	DO
11	2′-6″ × 6′-8″	DO	D-4	DO	DO	DO	DO

Room Finish Schedule

① Mark no	② Room	③ Floor		④ Base		⑤ Walls								⑥ Ceiling			⑦ Materials	⑧ Paint & finish
						N		E		S		W						
		M	F	M	F	M	F	M	F	M	F	M	F	M	F	Ht		
101	Office	1	A	4	D	6	C	6	C	7	C	7	C	7	D	8′-0″	1. Carpet (NIC)	A. Non req'd
102	Storage	2	A	4	E	7	D	6	D	7	D	7	D	7	D	8′-0″	2. Vinyl sheet	B. Wall paper (NIC)
103	Lab	5	A	4	E	7	D	6	D	7	D	7	D	7	D	8′-0″	3. Ceramic tile	C. Vinyl wall covering (NIC)
104	Dentist's office	1	A	4	F	8	F	6	A	8	F	8	F	7	H	8′-0″	4. Wood base	D. Semi-gloss enamel
105	Bath - dentist	3	A	4	F	7	B	6	B	7	B	7	B	7	H	8′-0″	5. Vinyl base	E. Flat wall latex
106	Storage	1	A	4	E	7	D	7	D	7	D	7	D	7	D	8′-0″	6. Concrete-bare	F. Stain/varnish
107	X-ray lab	2	A	5	A	7	D	7	D	7	D	7	D	7	A	8′-0″	7. Gypsum walled	G. Semi-transp stain
108	Storage	6	A	4	E	7	A	6	A	7	A	7	A	7	A	Varies	8. Wood paneling	H. Accoustical texture

(NIC) = Not in contract
M = Material
F = Finish

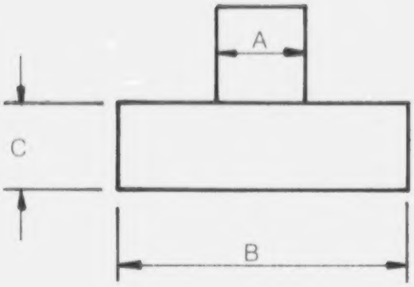
Column and Beam Schedule

① ② ③ ④ ⑤

Mk	No	Description	Length	Remarks
1	4	3½″ steel-pipe standard column w/plates	7′-6″	—
2	1	W8 × 31 wide flange	12′-0″	To be bolted to W10 × 24 below
3	12	C12 × 20.7 steel channels	9′-0″	—

Footing Schedule

①	②	③	④	⑤	⑥	⑦
Mk	**A**	**B**	**C**	**Elev**	**Reinf**	**Remarks**
1	8″	1′-4″	8″	93.4′	2 #4	Reinf bars each way
2	10″	1′-6″	8″	93.4′	2 #4	Reinf bars each way
3	8″	1′-4″	8″	97.4′	None	—



Electrical Schedule
(Fixture Schedule)

①	②	③	④	⑤	⑥
***Location**	**Symbol**	**No**	**Watt/ amp**	**Description**	**Manuf/cat no**
Lobby	⊜ $\odot_E$	2 2	100 100	Duplex outlet Flush ceiling	Seymour #41-1 DO #40-2
Conference room	⊜ $\odot_B$	6 2	100 60	Duplex outlet Wall valance	General #1606 DO
Bathroom #1	⊜ $\odot_A$	2 2	100 100	Duplex outlet Ceiling mount	Seymour #41-1 DO #41-3

*Mark number may be indicated

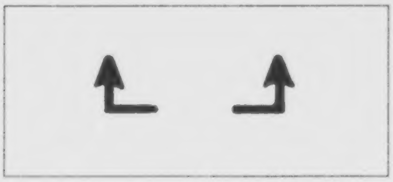
INTRODUCTION TO WORKING DRAWINGS
UNIT 4

INFORMATION SHEET

1. **Terms and definitions associated with working drawings**

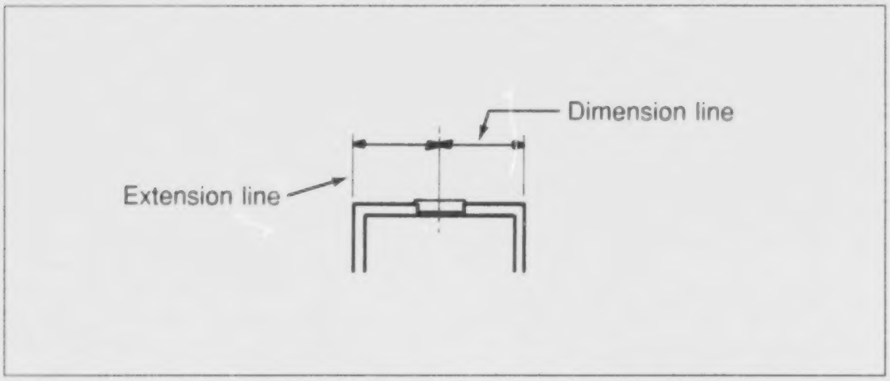
   a. **Cutting-plane line** (Figure 1)—Heavy broken line indicating plane at which a cross section is taken and the direction of viewing the object

   FIGURE 1



   b. **Dimension line** (Figure 2)—Line indicating dimension of a part or member

   FIGURE 2



   c. **Extension line** (see Figure 2)—Line extending from object line to dimension line

   d. **Line intersection**—Point where two lines meet

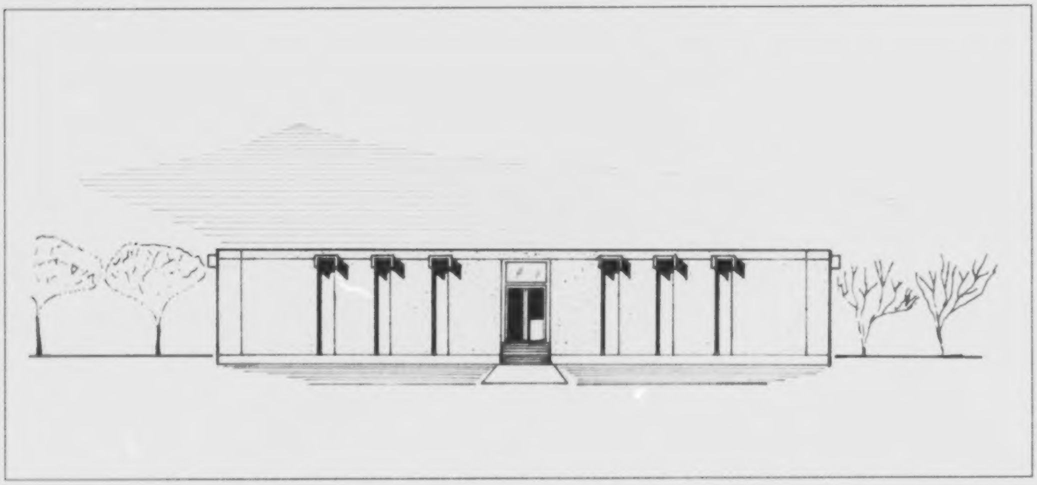
   e. **Mechanical drawing**—Drawing showing location and details about plumbing components and heating and air-conditioning units

   NOTE: Mechanical features may be drawn on the basic floor or foundation plan, or may be shown in separate drawings.

   f. **Presentation drawing** (see Figure 3)—Drawing having many of the features of a photograph; drawn by the architect to interest clients

INFORMATION SHEET

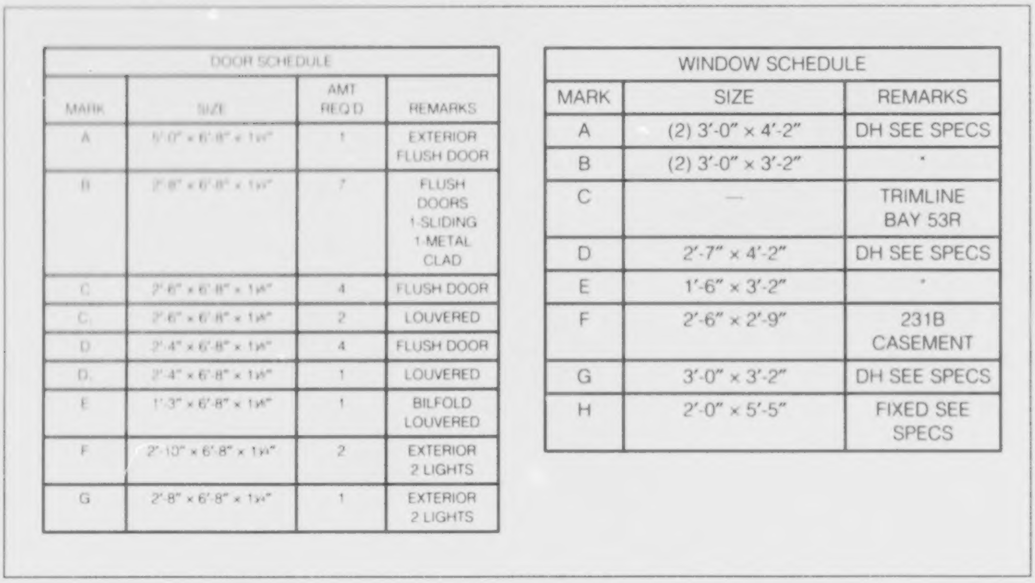
FIGURE 3: Presentation drawing



g. **Schedule** (Figure 4)—Listing or chart of parts (keyed to the plans), amounts, materials or products, and details

NOTE: Schedules may appear on the same page as a plan or on a separate page in the set of plans. Schedules may be listed for windows, doors, room finishes, paint, appliances, fixtures, lintels, headers, and reinforcing steel. See the various schedules included in the sample set of drawings available with this publication.

FIGURE 4



DOOR SCHEDULE			
MARK	SIZE	AMT REQ'D	REMARKS
A	5'-0" × 6'-8" × 1¾"	1	EXTERIOR FLUSH DOOR
B	2'-8" × 6'-8" × 1¾"	7	FLUSH DOORS 1-SLIDING 1-METAL CLAD
C	2'-6" × 6'-8" × 1¾"	4	FLUSH DOOR
C_1	2'-6" × 6'-8" × 1¾"	2	LOUVERED
D	2'-4" × 6'-8" × 1¾"	4	FLUSH DOOR
D_1	2'-4" × 6'-8" × 1¾"	1	LOUVERED
E	1'-3" × 6'-8" × 1¾"	1	BILFOLD LOUVERED
F	2'-10" × 6'-8" × 1¾"	2	EXTERIOR 2 LIGHTS
G	2'-8" × 6'-8" × 1¾"	1	EXTERIOR 2 LIGHTS

WINDOW SCHEDULE		
MARK	SIZE	REMARKS
A	(2) 3'-0" × 4'-2"	DH SEE SPECS
B	(2) 3'-0" × 3'-2"	"
C	—	TRIMLINE BAY 53R
D	2'-7" × 4'-2"	DH SEE SPECS
E	1'-6" × 3'-2"	"
F	2'-6" × 2'-9"	231B CASEMENT
G	3'-0" × 3'-2"	DH SEE SPECS
H	2'-0" × 5'-5"	FIXED SEE SPECS

INFORMATION SHEET

h. **Specifications**—Detailed set of written instructions that supplements the set of plans, describes equipment and materials used in the structure, and becomes part of the contract

i. **Structural drawing**—Drawing by a structural engineer or architect; may accompany working plans and give important information about structure's foundation, skeleton, and floor systems

j. **Working drawings**—Set of detailed drawings or plans drawn to scale by a drafter; shows all information and dimensions necessary to build or remodel a structure

NOTE: Working drawings consist of several different kinds of drawings, usually assembled into a set: plot plan; foundation plan; floor plan(s); elevation drawings; section drawing(s); detail drawings; electrical drawings; heating, ventilation, and air conditioning (HVAC) drawings; and plumbing drawings. The set will also include finish schedules, a perspective drawing, and a structural drawing. See the sample set of drawings available with this publication.

2. **Types of drawings usually included in a set of working drawings and their descriptions**

a. **Plot plan** (site plan)—Horizontal view showing where structure is to be located on a site (see Sheet 1 in sample set of drawings)

b. **Foundation plan**—Horizontal view of entire substructure below first floor or frame of structure (see Sheet S1 in sample set of drawings)

c. **Floor plan**—Horizontal view of structure, showing length and breadth of structure and layout of rooms on that floor (see Sheet 3 in sample set of drawings)

NOTE: Of all the drawings that comprise a full set of plans, none is more important than the floor plan. The floor plan includes not only the greatest amount of information, but is the basis for all the other drawings that must be developed. A floor plan is constructed by taking an imaginary cutting plane through the structure about half way (commonly 48 inches) between the floor and ceiling, and then drawing a plan view of what remains below the cutting plane. (See Figure 5.)

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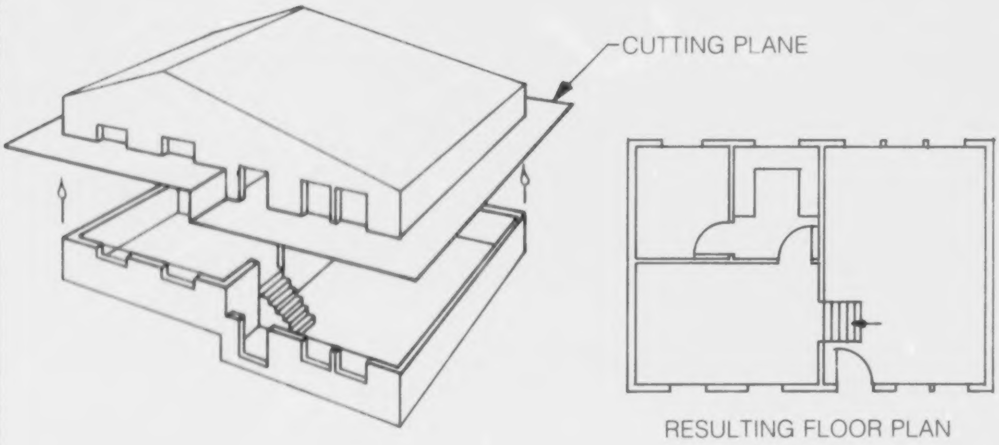
FIGURE 5: Constructing a floor plan



d. **Elevation**—Vertical two-dimensional view showing shape and design of each of the exterior or interior faces of a structure (see Sheets 4 and 9 in sample set of drawings)

e. **Section**—Cut-away view through an object or wall to show its interior makeup (see Sheets 5 through 7 in sample set of drawings)

NOTE: Section drawings may be drawn on the same sheet as an elevation or plan drawing, or may appear on a separate sheet in the set of drawings.

f. **Detail**—Large-scale graphic of part of another drawing, indicating special features of design, location, and composition and the correlation of the elements and materials shown (see Sheets 5 through 7 in sample set of drawings)

NOTE: Detail drawings often use the cut-away section view to show aspects that are too small to be shown in sufficient detail on plan or elevation drawings. Like section drawings, detail drawings may be drawn on the same sheet as an elevation or plan drawing or may appear on a separate sheet in the set of drawings.

INFORMATION SHEET

g. **Electrical floor plan**—Floor plan with electrical symbols showing exact location of switches, outlets, and electrical devices to accommodate appliances and fixtures; also lines that represent wiring from each switch to the connecting fixture (see Sheets E1 and E2 in sample set of drawings)

h. **Heating, ventilating, and air-conditioning** (HVAC) **floor plan**—Floor plan with heating, ventilating, and air-conditioning symbols showing location and types of equipment, movement of hot and cold air, and location and size of ducts and diffusers (see Sheet M3 in sample set of drawings)

i. **Plumbing floor plan**—Floor plan with symbols representing location and type of fixtures, vents, valves, and pipe that will be installed in the structure (see Sheet M2 in sample set of drawings)

3. **Descriptions of information found on types of drawings in a set of working drawings**

a. **Plot plan** (site plan) (see Sheet 1 in sample set of drawings)

(1) Location, dimensions, and elevation of structure on site

(2) Finished and existing grade contours

(3) Property lines and dimensions

(4) Location of utilities

(5) Location of existing conditions

EXAMPLES: Trees, utility buildings, other structures

(6) Location and dimensions of driveways, walks, and streets

(7) Legal description of property

(8) Vicinity map

NOTE: A vicinity map is a small illustration showing a structure's location relative to streets and/or other major landmarks.

b. **Foundation plan** (see Sheet S1 in sample set of drawings)

(1) Location and dimensions of footings, grade beams, foundation walls, stem walls, piers, equipment footings, foundations

(2) Location of anchor bolts (in detail view)

(3) Reinforcing steel

INFORMATION SHEET

c. **Floor plan** (see Figure 6 and Sheet 3 in sample set of drawings)

(1) Building size drawn to scale

(2) Location and thicknesses of interior partition walls

(3) Location and swing of doors

(4) Location of stairways and elevators

(5) Location of windows

(6) Location of mechanical and electrical chases

(7) Location of built-in equipment

EXAMPLES: Bathroom fixtures, cabinetry, mechanical fixtures

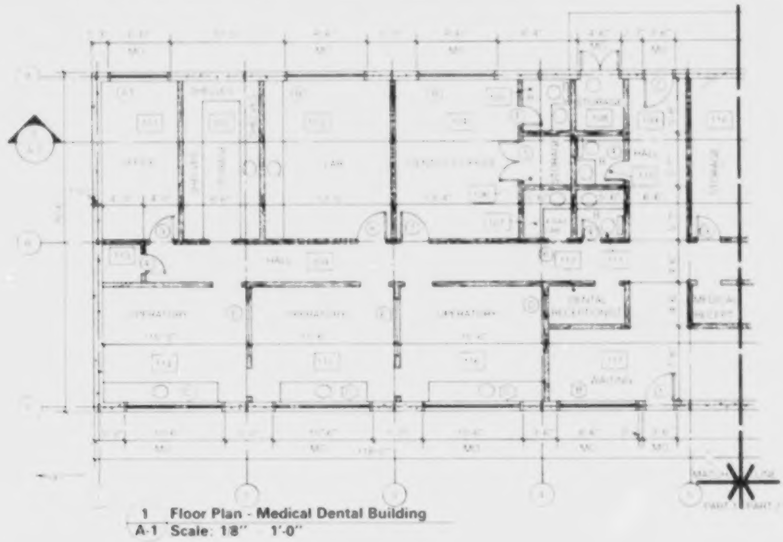
(8) Material symbols

(9) Identification symbols

EXAMPLE: Room numbers

(10) Dimensions and notes

FIGURE 6: Floor plan


OFFICE
LAB
HALL
STORAGE
HALL
OPERATORY
OPERATORY
OPERATORY
DENTAL RECEPTIONIST
MEDICAL RECEPT.
WAITING
1 Floor Plan - Medical Dental Building
A-1 Scale: 1/8" = 1'-0"

INFORMATION SHEET

d. **Elevation** (see Sheets 4 and 9 in sample set of drawings)

   (1) Grade lines

   (2) Floor height

   (3) Window and door types

   (4) Roof lines and slope, roofing material, vents, gravel stops, projection of eaves

   (5) Exterior finish materials and trim

   (6) Exterior dimensions

e. **Section** (see Sheets 5 through 7 in sample set of drawings)

   (1) Details of construction and information about stairs, walls, chimneys, or other parts of construction that may not show clearly on plan

   (2) Floor levels in relation to grade

   (3) Wall thicknesses at various locations

   (4) Anchors and reinforcing steel

f. **Detail** (see Sheets 5 through 7 in sample set of drawings)

   NOTE: The following list itemizes types of information that may require a detail drawing. All of the items listed would never appear on a single detail drawing.

   (1) Footings and foundations, including anchor bolts, reinforcing, control joints

   (2) Beams, floor joists, bridging, other support members

   (3) Sills, floor framing, exterior walls, vapor barriers

   (4) Floor heights, thicknesses, expansion, reinforcing

   (5) Interior walls/partition walls

   (6) Windows, exterior and interior doors, door frames, special openings

   (7) Roof, cornice, soffit, ceilings, eaves, gutters, downspouts

   (8) Gravel stops, fascia, flashing

   (9) Fireplaces, chimneys

   (10) Staircases, stair assembly

   (11) Millwork, trim, ornamental iron, specialty items

INFORMATION SHEET

4. Standard sequence of drawings in a set of working drawings

NOTE: The packaging of a set of working drawings is very specific in its arrangement. This arrangement helps a reader locate a certain section of the drawings before proceeding to a particular document.

a. **Cover sheet** (title sheet) (see Sheet 1 in sample set of drawings)

NOTE: The cover sheet is the first sheet in a set of plans. It lists the project name, the client's name, and the address of the structure; provides a table of contents that indexes the sheets contained in the working drawings; and lists schedule of notations, symbols, and abbreviations used in the drawings. Many times, a pictorial rendering of the project will also appear on the cover sheet.

b. **Architectural drawings** (see Sheets 1 through 11 in sample set of drawings)

NOTE: Architectural drawings include a site plan, floor plans, schedules, roof plan, elevations, sections, and details.

c. **Structural drawings** (see Sheets S1 and S2 in sample set of drawings)

NOTE: Structural drawings include foundation plans, structural sections, framing plans, and structural details.

d. **Mechanical drawings** (see Sheets ME1 and M1 through M3 in sample set of drawings)

NOTE: Mechanial drawings include plumbing plans, plumbing details, mechanical fixtures, HVAC plans, and HVAC details.

e. **Electrical drawings** (see Sheets E1 and E2 in sample set of drawings)

NOTE: Electrical drawings include power-distribution plans, communication systems, fire-protection systems, lighting plans, fixture plans, fixture schedules, and electrical details.

5. Description of drawing-identification system used in a set of working drawings

NOTE: A drawing-identification system has been established to help a reader locate any desired drawing within a complete set of working drawings.

a. Drawing-identification system consists of an alphnumeric callout placed on the title block located on each drawing.

b. The letter in the callout relates directly to the type of drawing shown on the sheet.

EXAMPLE: All architectural-drawing callouts begin with the letter A.

c. The number in the callout indicates the sequence of the sheet within the section where the drawing appears.

EXAMPLES: page 1, page 2, or page 3

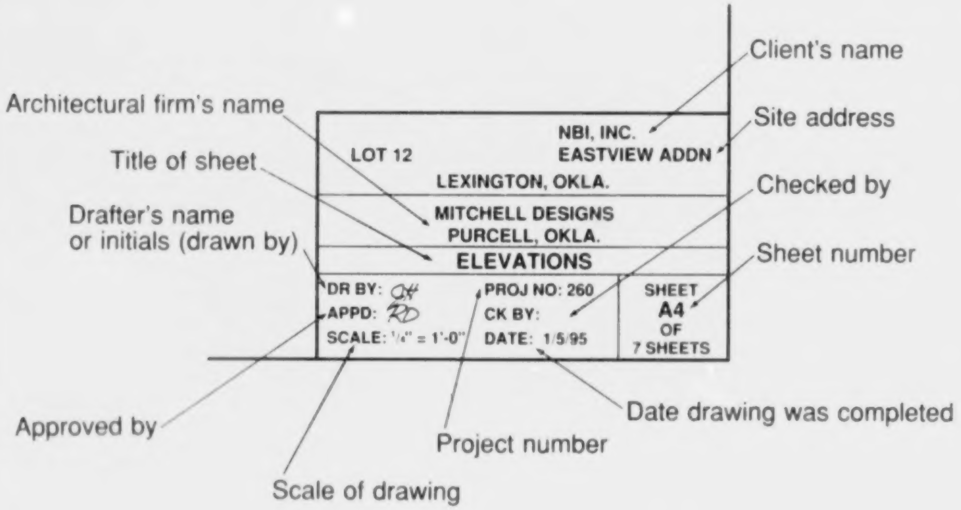
INFORMATION SHEET

d. Therefore, architectural-drawing callouts are numbered A1, A2, A3, etc.; structural-drawing callouts are numbered S1, S2, S3, etc.; mechanical-drawing callouts are numbered M1, M2, M3, etc.; and electrical-drawing callouts are numbered E1, E2, E3, etc.

6. Components of a title block

NOTE: Every sheet in a working set of drawings includes a title block. The title block is usually located in the lower right-hand corner of the drawing but may sometimes be extended along the entire right side of the drawing. Figure 7 shows the minimum components a drafter should provide on a title block.

FIGURE 7: Title block



Client's name
Architectural firm's name
Site address
Title of sheet
Checked by
Drafter's name or initials (drawn by)
Sheet number
NBI, INC.
LOT 12
EASTVIEW ADDN
LEXINGTON, OKLA.
MITCHELL DESIGNS
PURCELL, OKLA.
ELEVATIONS
DR BY:
APPD:
SCALE: ¼" = 1'-0"
PROJ NO: 260
CK BY:
DATE: 1/5/95
SHEET
A4
OF
7 SHEETS
Approved by
Date drawing was completed
Project number
Scale of drawing

7. Standard architectural-linework techniques

NOTE: Architectural drafting employs linework techniques that allow for clarity and readability of the complex drawings produced. Proper use of these preferred linework techniques is essential for producing quality architectural drawings.

a. **Line-weight contrast**

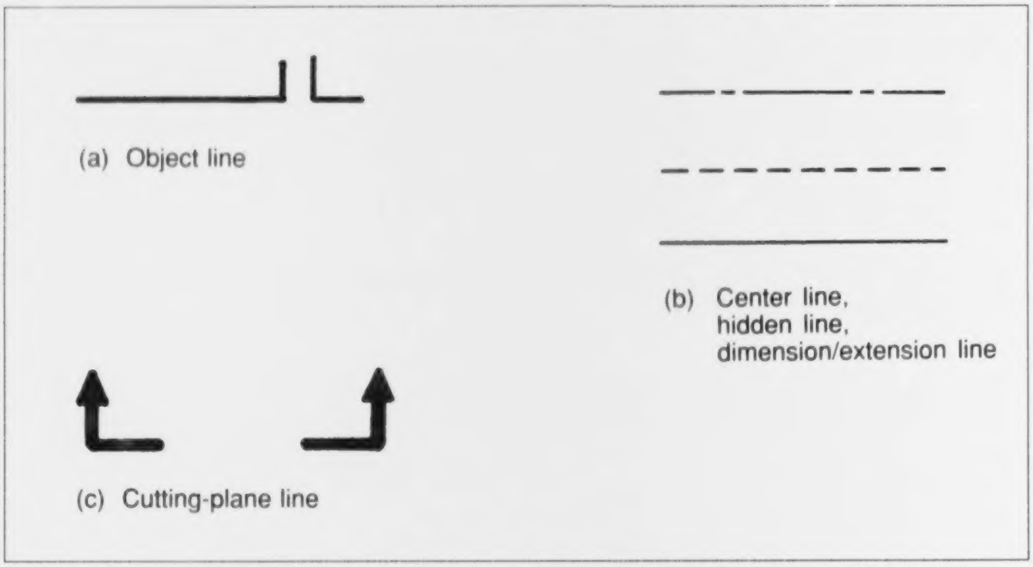
(1) Object lines are drawn as heavy lines to create a silhouette of the object being drawn (see Figure 8-a)

INFORMATION SHEET

(2) Center lines, extension lines, hidden lines, and dimension lines are drawn as thin lines so as not to blend in with or overpower object lines (see Figure 8-b)

(3) Cutting-plane lines are drawn as extremely heavy lines that allow for quick identification (Figure 8-c)

FIGURE 8



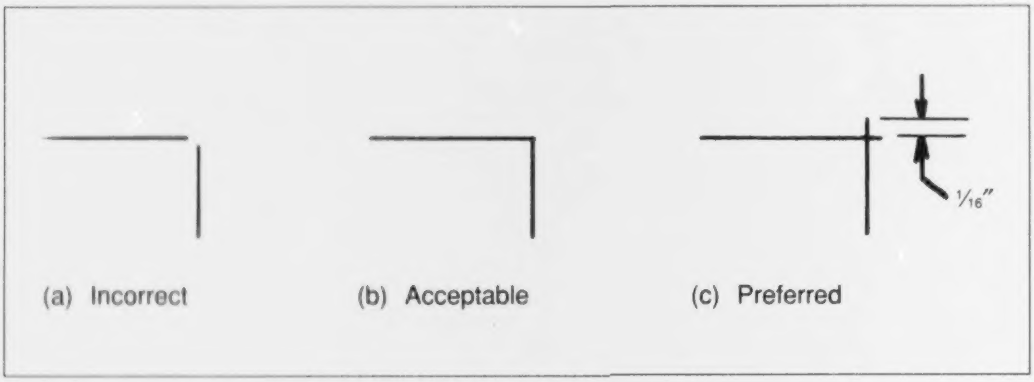
(a) Object line

(b) Center line, hidden line, dimension/extension line

(c) Cutting-plane line

b. **Line intersections** (Figure 9)—Intersecting lines are extended approximately 1/16 inch beyond one another

FIGURE 9



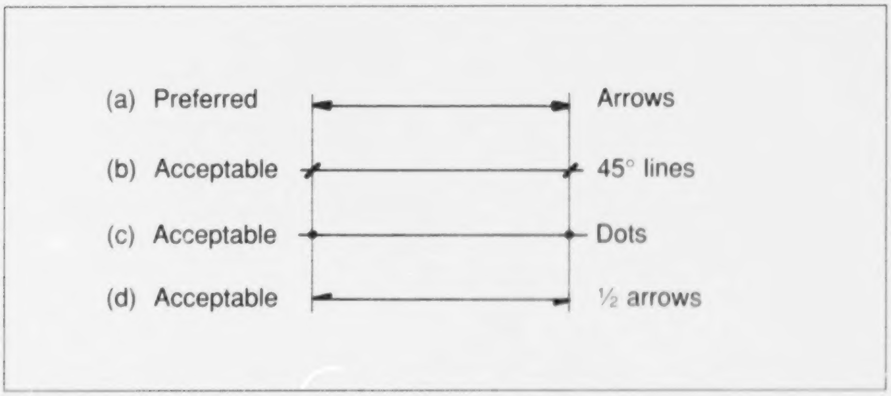
(a) Incorrect

(b) Acceptable

(c) Preferred

c. **Arrowheads** (Figure 10)—Four types of arrowheads are permitted on architectural drawings; however, a drafter should show consistency in using the arrowhead type chosen

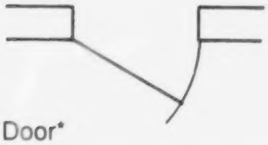
FIGURE 10


(a) Preferred
Arrows
(b) Acceptable
45° lines
(c) Acceptable
Dots
(d) Acceptable
½ arrows

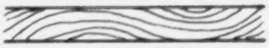
8. **Plan symbols used on floor plans** (Table 1)

NOTE: Symbols are used on drawings to provide simple representations of often-complex objects, therefore allowing a quick understanding of the layout and construction of a structure. Shown below are common symbols shown on floor-plan drawings.

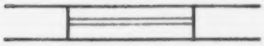
TABLE 1: Symbols used on floor plans



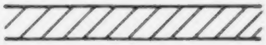
Door*



Wood



Window (general)**



Brick

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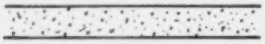
* Different types of doors may have slightly different symbols.

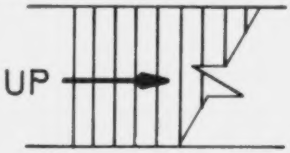
** Different types of windows may have slightly different symbols.

INFORMATION SHEET

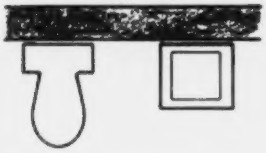
TABLE 1 (cont.)



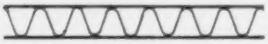
Concrete



Stairway



Bathroom fixtures

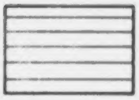


Metal stud to drywall

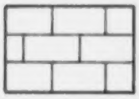
9. **Plan symbols used on elevation drawings** (Table 2)

NOTE: The symbols shown below are commonly used on elevation drawings to represent natural and man-made construction materials.

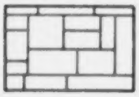
TABLE 2: Symbols used on elevation drawings



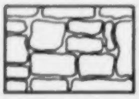
Brick



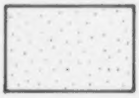
Concrete block



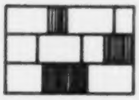
Cut stone



Rock



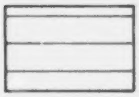
Concrete



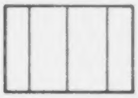
Wood shingle

INFORMATION SHEET

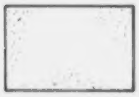
TABLE 2 (cont.)



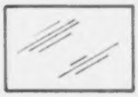
Horizontal wood siding



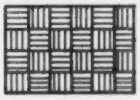
Vertical wood siding



Stucco



Glass



Earth

10. Symbols and methods used in cross-referencing drawings

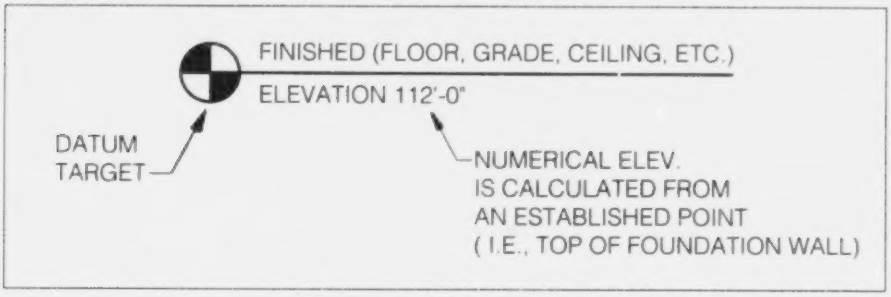
NOTE: In developing a set of working drawings, you will find it necessary to cross-reference one drawing to another for various reasons (i.e., locating a section drawing that was identified on the floor plan). Being able to reference certain types of drawings and various sheets to one another in an organized manner is vital in being able to interpret and construct a building from a set of plans. This section will detail some of the generally accepted reference methods and symbols as well as their use on architectural drawings.

a. **Symbols**

(1) **Datum-target symbol** (Figure 11)

NOTE: A datum target is an established, permanent elevation reference. The datum-target symbol is used on drawings to indicate finish elevations with datum targets. See Figure 12.

FIGURE 11


FINISHED (FLOOR, GRADE, CEILING, ETC.)
ELEVATION 112'-0"
DATUM TARGET
NUMERICAL ELEV. IS CALCULATED FROM AN ESTABLISHED POINT (I.E., TOP OF FOUNDATION WALL)

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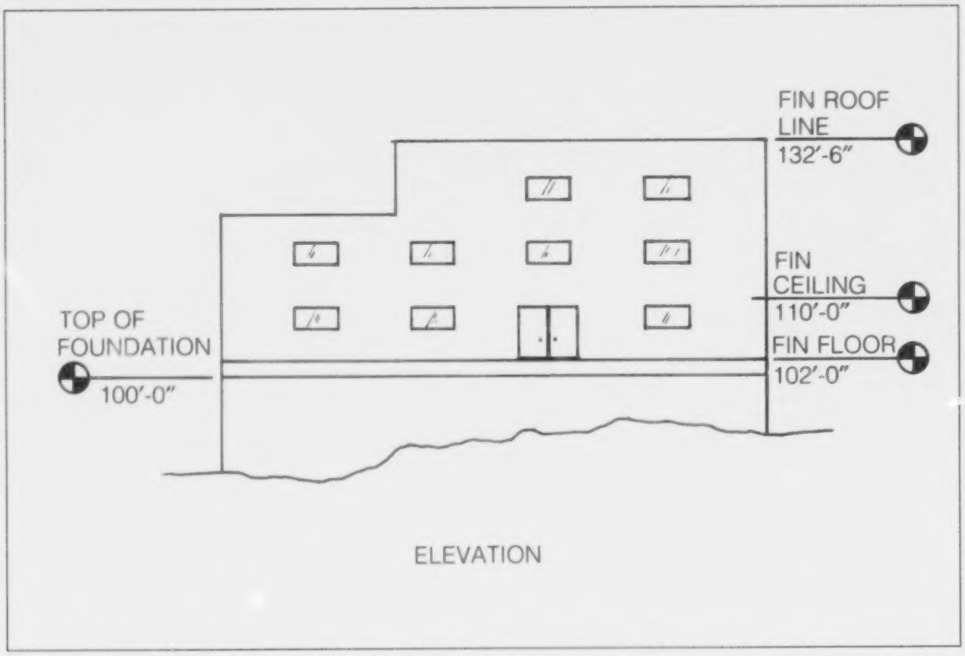
INFORMATION SHEET

FIGURE 12


FIN ROOF
LINE
132'-6"
FIN
CEILING
110'-0"
TOP OF
FOUNDATION
100'-0"
FIN FLOOR
102'-0"
ELEVATION

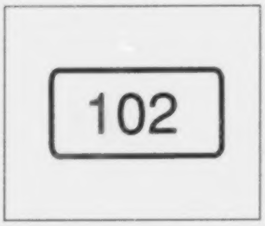
(2) **Schedule symbols**

NOTE: Geometric shapes other than the ones shown below may be used on some drawings as long as symbols are unique and consistent within the set of plans developed.

- Room-identification symbol (Figure 13)

  NOTE: A room-identification symbol consists of a geometric shape surrounding a number. These symbols are used to identify particular rooms on all drawings as well as to reference room finish schedules.

FIGURE 13

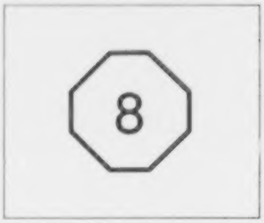


INFORMATION SHEET

- Window-identification symbol (Figure 14)

  NOTE: Window-identification symbols are used on floor plans and window details and to reference window schedules.

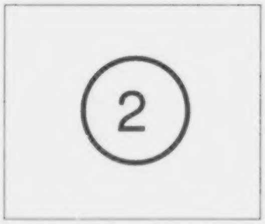
FIGURE 14



- Door-identification symbol (Figure 15)

  NOTE: Door-identification symbols are used on floor plans and door details and to reference door schedules.

FIGURE 15



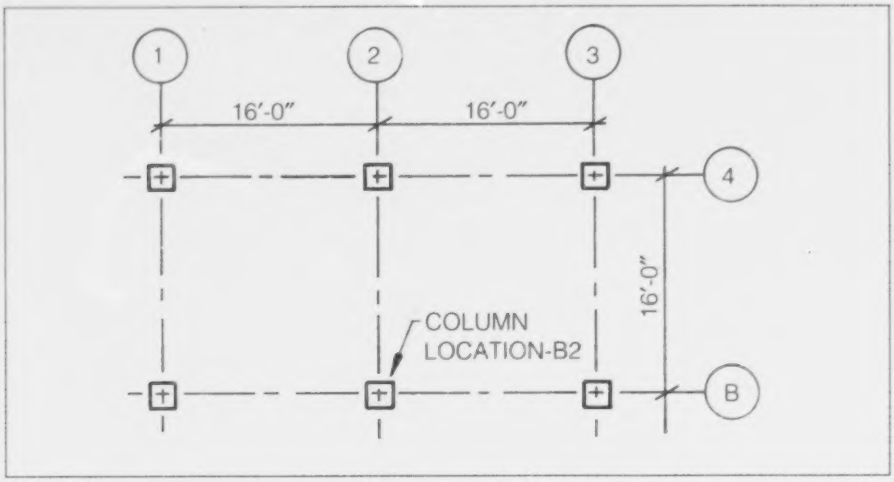
b. **Methods**

(1) **Plan-grid method** (see Figure 16)

NOTE: Centering columns and other supports on a consistent spacing is a common construction method used to make maximum use of materials and to generate the greatest amount of open interior space. When this construction method is to be used, working drawings can then utilize the plan-grid method for dimensioning, and building locations on drawings can be identified with an alphanumeric callout. For example, see column B2 in Figure 16 on the following page.

INFORMATION SHEET

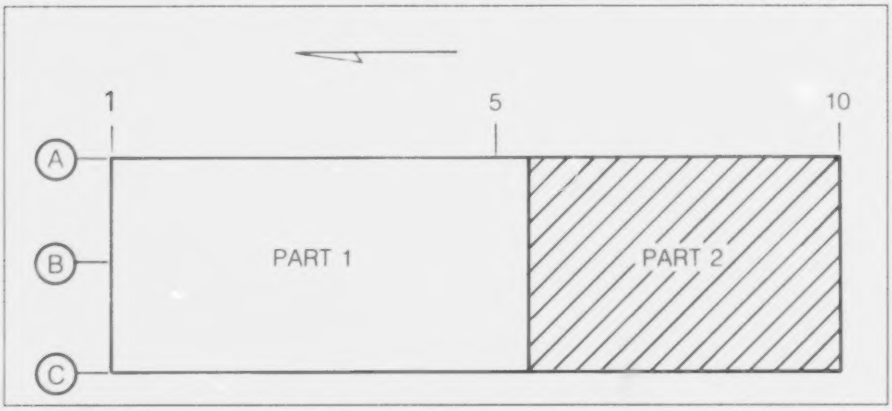
FIGURE 16



(2) **Key-plan method** (Figure 17)

NOTE: A key plan is shown on the drawing sheets of a large building project where only a portion of the building will fit on a single sheet. The key plan on a sheet identifies which area of the building is being shown on that particular sheet.

FIGURE 17

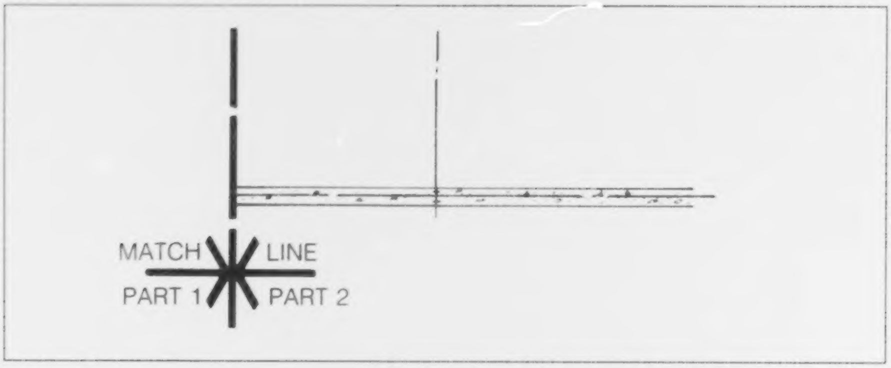


(3) **Match-line method** (see Figure 18)

NOTE: Used in conjunction with a key plan, a match line denotes a common point of reference on a building that will enable a reader to visualize where the building starts and stops from sheet to sheet.

INFORMATION SHEET

FIGURE 18



11. **Standard headings presented in drawing schedules**

NOTE: Schedules consist of detailed information shown in tabular form as a means of conveying necessary information to builders and manufacturers. Schedules are almost always necessary except on the simplest of structures.

a. **Window schedule** (see Table 3)

(1) Symbol used for type of window referenced

(2) Dimensions of window referenced

(3) Type of window referenced (fixed, sliding, swinging, etc.)

(4) Manufacturer's name and catalog number of window referenced

(5) Further description of window referenced

(6) Type of glazing to be used on window referenced (single- or double-strength, plate, insulated, etc.)

b. **Door schedule** (see Table 4)

(1) Symbol used for type of door referenced

(2) Dimensions of door referenced

(3) Manufacturer's name and catalog number of door referenced

(4) Further description of door referenced

(5) Material (wood, steel, aluminum, etc.) to be used in the manufacture of door referenced

INFORMATION SHEET

(6) Thickness (front to back dimensions) of door referenced

(7) Type of door (panel, solid, sliding, etc.) referenced

TABLE 3: Window schedule

①	②	③	④	⑤	⑥
Sym	**Size**	**Type**	**Mfgr & catalog no**	**Remarks**	**Glass**
A	6′-0″ × 4′-0″	Fixed	"E-Z set" 7248C	Alum w/plastic screens	Thermopane
B	8′-0″ × 4′-0″	DO	DO 9648C	DO	DO
C	10′-0″ × 3′-0″	DO	DO 12036C	DO	DO
D	2′-0″ × 4′-0″	DO	DO 2448M	Wood trim	¼″ PP
E	6′-0″ × 4′-0″	DO	DO 7248M	DO	DO
F	7′-0″ × 4′-0″	DO	DO 8448C	Alum w/plastic screens	Thermopane
G	6′-0″ × 3′-0″	DO	DO 7236C		DO

TABLE 4: Door schedule

①	②	③		④	⑤	⑥	⑦
Sym	**Size**	**Mfgr & catalog no**		**Remarks**	**Material**	**Thk**	**Type**
1	3′-0″ × 6′-8″	Phillips	Housemart	3 coats ext trim paint	Metal	1¾″	Solid
2	3′-0″ × 6′-8″	DO	M-1 M-5	DO	DO	DO	DO
3	2′-0″ × 6′-8″	DO	M-91	DO	DO	DO	DO
4	2′-0″ × 6′-8″	DO	A-4	Stain & lacq finish	Birch	1⅜″	Hollow core
5	2′-0″ × 6′-8″	DO	A-10	DO	DO	DO	DO
6	2′-0″ × 6′-8″	DO	B-17	DO	Pine	DO	Bifold
7	3′-0″ × 6′-8″	DO	A-5	DO	Birch	DO	Solid core
8	3′-0″ × 6′-8″	DO	A-17	DO	DO	DO	Hollow core
9	2′-6″ × 6′-8″	DO	A-21	DO	DO	DO	DO
10	2′-10″ × 6′-8″	DO	D-7	DO	DO	DO	DO
11	2′-6″ × 6′-8″	DO	D-4	DO	DO	DO	DO

INFORMATION SHEET

c. **Room finish schedule** (Table 5)

(1) Number identifying room referenced

(2) Type of room referenced

(3) Reference callout for type of floor (concrete, hardwood, carpet, etc.) to be used in room referenced

NOTE: The callout used in this column relates to the materials and finish lists given in Columns 7 and 8 in Table 5 below.

(4) Reference callout for type of base (baseboard) to be used in room referenced

NOTE: The callout used in this column relates to the materials and finish lists given in Columns 7 and 8 in Table 5 below.

(5) Material and finish callout for each wall (north, east, south, west) in room referenced

NOTE: The callout used in this column also relates to the materials and finish lists given in Columns 7 and 8 in Table 5 below.

(6) Material and finish callouts and height of ceiling in room referenced

NOTE: The material and finish callout used in this column relates to the materials and finish lists given in Columns 7 and 8 in Table 5 below.

(7) Materials listing and reference numbers used in schedule

(8) Paint and finish listing and reference numbers used in schedule

TABLE 5: Room finish schedule

①	②	③		④		⑤								⑥			⑦	⑧
						Walls								Ceiling				
		Floor		Base		N		E		S		W						
Mark no	Room	M	F	M	F	M	F	M	F	M	F	M	F	M	F	Ht	Materials	Paint & finish
101	Office	1	A	4	D	6	C	6	C	7	C	7	C	7	D	8'-0"	1 Carpet (NIC)	A Non req'd
102	Storage	2	A	4	E	7	D	6	D	7	D	7	D	7	D	8'-0"	2. Vinyl sheet	B Wall paper (NIC)
103	Lab	5	A	4	E	7	D	6	D	7	D	7	D	7	D	8'-0"	3 Ceramic tile	C Vinyl wall covering (NIC)
104	Dentist's office	1	A	4	F	8	F	6	A	8	F	8	F	7	H	8'-0"	4 Wood base	D Semi-gloss enamel
105	Bath - dentist	3	A	4	F	7	B	6	B	7	B	7	B	7	H	8'-0"	5 Vinyl base	E Flat wall latex
106	Storage	1	A	4	E	7	D	7	D	7	D	7	D	7	D	8'-0"	6 Concrete-bare	F Stain varnish
107	X-ray lab	2	A	5	A	7	D	7	D	7	D	7	D	7	A	8'-0"	7 Gypsum walled	G Semi-transp stain
108	Storage	6	A	4	E	7	A	6	A	7	A	7	A	7	A	Varies	8 Wood paneling	H Accoustical texture

(NIC) = Not in contract M = Material F = Finish

INFORMATION SHEET

d. **Column and beam schedule** (Table 6)

(1) Number identifying type of column or beam referenced

(2) Number indicating quantity required of column or beam referenced

(3) Description of column or beam referenced; lists size, type, and material to be used in constructing column or beam

(4) Length (in feet) of column or beam referenced

(5) Any further information that may be needed about column or beam referenced

TABLE 6: Column and beam schedule

① **Mk**	② **No**	③ **Description**	④ **Length**	⑤ **Remarks**
1	4	3½″ steel-pipe standard column w/plates	7′-6″	—
2	1	W8 × 31 wide flange	12′-0″	To be bolted to W10 × 24 below
3	12	C12 × 20.7 steel channels	9′-0″	—

e. **Footing schedule** (see Table 7)

(1) Number identifying footing referenced on drawing

(2) "A" dimension of footing referenced on drawing

(3) "B" dimension of footing referenced on drawing

(4) "C" dimension of footing referenced on drawing

(5) Elevation of footing referenced (as it relates to an established benchmark elevation)

(6) Size and quantity of any reinforcement bars required for footing referenced

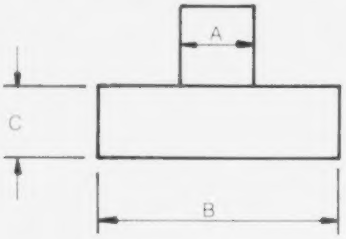
(7) Any further information that may be needed for footing referenced

INFORMATION SHEET

TABLE 7: Footing schedule

① ② ③ ④ ⑤ ⑥ ⑦

Mk	A	B	C	Elev	Reinf	Remarks
1	8″	1′-4″	8″	93.4′	2 #4	Reinf bars each way
2	10″	1′-6″	8″	93.4′	2 #4	Reinf bars each way
3	8″	1′-4″	8″	97.4′	None	—



f. **Electrical schedule** (Table 8)

(1) Type of room where electrical fixture referenced is to be installed

(2) Graphic symbol for type of electrical fixture referenced

(3) Quantity required for electrical fixture referenced

(4) Watts or amperage required for electrical fixture referenced

(5) Description of type of electrical fixture referenced

(6) Name of manufacturer and catalog number of electrical fixture referenced

TABLE 8: Electrical schedule

① ② ③ ④ ⑤ ⑥

*Location	Symbol	No	Watt/ amp	Description	Manuf/cat no
Lobby	⊖ $\odot_E$	2 2	100 100	Duplex outlet Flush ceiling	Seymour #41-1 DO #40-2
Conference room	⊖ $\odot_B$	6 2	100 60	Duplex outlet Wall valance	General #1606 DO
Bathroom #1	⊖ $\odot_A$	2 2	100 100	Duplex outlet Ceiling mount	Seymour #41-1 DO #41-3

*Mark number may be indicated

INTRODUCTION TO WORKING DRAWINGS
UNIT 4

ASSIGNMENT SHEET 1—PREPARE A TITLE BLOCK

Name ______________________ Score __________

Introduction A well-organized, complete title block is necessary to provide the document's reader with required information. In Objective 6 of the information sheet, you learned the minimum components a drafter must include in providing this important information. In this assignment sheet, you will practice organizing information in a title block.

Exercise

Directions On a blank sheet of 8½" × 11" vellum, reproduce your school's title block. Complete the title block with a border and fill in the appropriate information required.

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INTRODUCTION TO WORKING DRAWINGS
UNIT 4

ASSIGNMENT SHEET 2—DETERMINE APPROPRIATE DRAWING SCALES

Name ______________________________ Score ______________

Introduction

In order to prevent eventual redrawing or severe overcrowding on drawings, you must be able to mentally plan drawing layouts and choose the correct drawing scales. The following guidelines will help you in selecting the proper drawing scale.

- First, determine the proper scale to use in developing the floor plan. To select a proper scale for the floor plan of a structure, consider its overall size (length and width), then consider that, as a general rule, the actual plan of the structure should occupy no more than 50 percent of the drawing area. Leaving the additional drawing area will allow sufficient space for dimensions, callouts, legends, and general notes to be added to the floor plan.
- Second, draw elevations at the same scale selected for the floor plan. Drawing elevations at the same scale allows you to project the elevations from the floor plan and keeps all the drawings in the same proportion.
- Common scales used for both floor plans and elevations are listed below.

Common floor-plan scales

• Residential	• Commercial
¼″ = 1′-0″	¼″ = 1′-0″
⅛″ = 1′-0″	⅛″ = 1′-0″
	1⁄16″ = 1′-0″

Common elevation-drawing scales

• Residential	• Commercial
¼″ = 1′-0″	¼″ = 1′-0″
⅛″ = 1′-0″	⅛″ = 1′-0″
	1⁄16″ = 1′-0″

Exercises

Part A

Directions

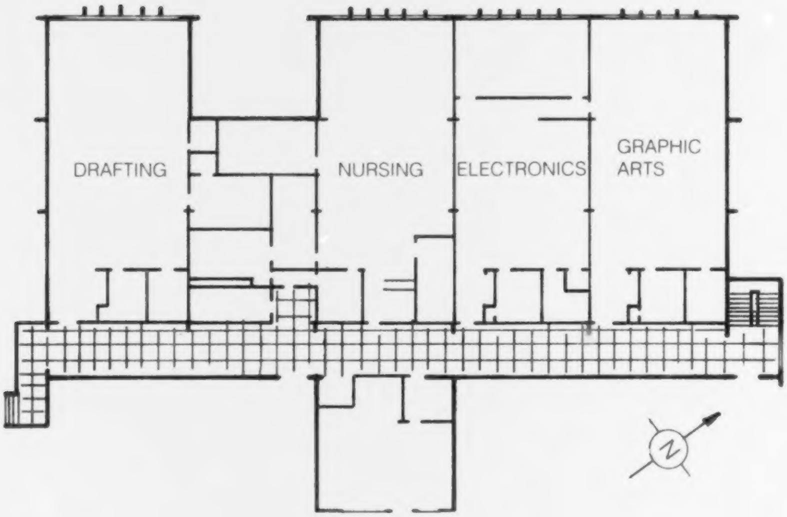
Using the criteria and the sketches shown in problem 1 and 2 on the following pages, determine the proper scale to be used in developing a floor plan for each problem. Write your answer on the blank line provided in each problem.

ASSIGNMENT SHEET 2

Problem 1

Criteria: Sheet size—24″ × 36″
Spacing—Allow a minimum of 4 inches all around the plan for dimensions and notes

Proper scale ______________________________

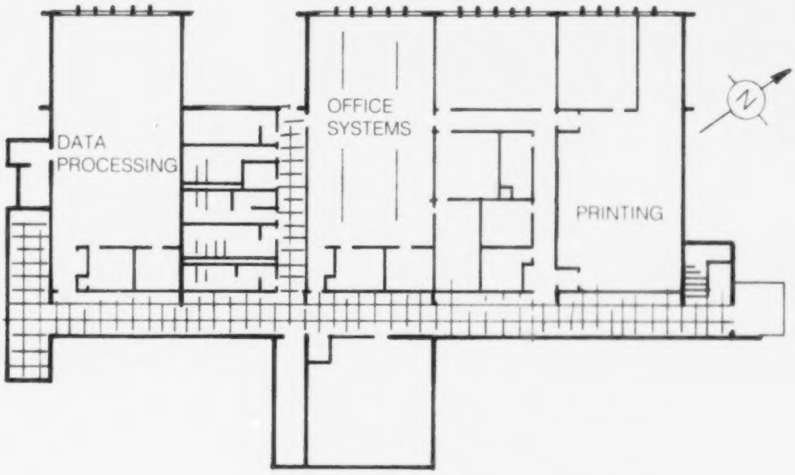

DRAFTING
NURSING
ELECTRONICS
GRAPHIC ARTS
N

ASSIGNMENT SHEET 2

Problem 2

Criteria: Sheet size—18″ × 24″
Spacing—Allow a minimum of 5 inches all around the plan for dimensions and notes

Proper scale ______________________________


DATA
PROCESSING
OFFICE
SYSTEMS
PRINTING
N

Part B

Directions On separate sheets of vellum, use the scales you determined in problems 1 and 2 in Part A above to lay out the floor plans on the sheet sizes given in the problems.

INTRODUCTION TO WORKING DRAWINGS
UNIT 4

ASSIGNMENT SHEET 3—DEVELOP A FLOOR PLAN

Name ______________________________ Score ______________

Introduction

As you learned in Objective 2 of the information sheet, the floor plan is the most important of the drawings that comprise a set of plans because it is the basis for all the other drawings that must be developed. In Objective 3 of the information sheet, you learned the components of a floor plan. In this assignment sheet, you will learn the general sequence of drawing steps used for developing the components of a floor plan. If this general sequence is followed, you will develop complete, well-organized plans. However, always use good judgment in evaluating a particular project. These steps are only general guidelines and may have to be altered to suit the particularities of a specific project.

General sequence of drawing steps for developing a floor plan

1. Select a suitable scale for the project.
2. Lay out overall length and width of structure.
3. Lay out all interior partition walls.
4. Locate and draw in all doors.
5. Locate and draw in all windows.
6. Locate stairways, elevators, and mechanical chases.
7. Draw all built-in fixtures and equipment.
8. Darken in lines with proper weight and contrast.
9. Place all identification symbols on drawing.
10. Draw in necessary material symbols.
11. Lay out placement of dimension lines.
12. Darken and complete finalized dimensions.
13. Add any necessary notes and callouts.
14. Complete title-block information.

NOTE: Items 11, 12, and 13 will be addressed further in Unit 7, "Architectural Dimensioning."

ASSIGNMENT SHEET 3

Exercise

Directions

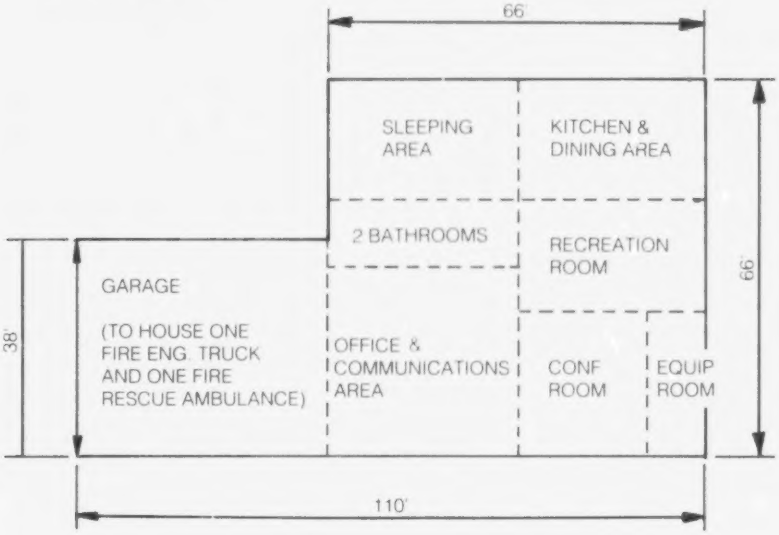
Study the scenario given below and then develop a floor plan for the proposed fire station described. Utilize reference materials (i.e., *Architectural Graphic Standards*) to determine the appropriate dimensions required to satisfy the fire station's general layout. Determine the scale to be used based upon the drawing-sheet size that your instructor assigns.

Scenario

To accommodate the growth of a city near you, the city government is currently considering the construction of a new fire station. A general layout has been agreed upon (see the illustration below). Using this general layout, develop on a separate sheet of vellum a finalized floor plan that includes appropriate square footage for each of the rooms identified in the illustration and the criteria given to determine wall thicknesses, column spacing, and other pertinent data.

Criteria:
Exterior walls—8-inch concrete block
Interior walls—3⅝-inch steel channel studs
Columns (interior)—4-inch-diameter steel posts on a 22′-0″ grid
Floor—Main building—4-inch concrete slab
Garage—6-inch concrete slab

General layout:


66'
SLEEPING AREA
KITCHEN & DINING AREA
2 BATHROOMS
RECREATION ROOM
GARAGE
(TO HOUSE ONE FIRE ENG. TRUCK AND ONE FIRE RESCUE AMBULANCE)
38'
OFFICE & COMMUNICATIONS AREA
CONF ROOM
EQUIP ROOM
66'
110'

INTRODUCTION TO WORKING DRAWINGS
UNIT 4

ASSIGNMENT SHEET 4—DEVELOP ELEVATION DRAWINGS

Name ______________________________ Score ______________

Introduction

In Objective 2 of the information sheet you learned that an elevation drawing is a vertical, two-dimensional view showing the shape and design of the exterior or interior faces of a structure. And, in Objective 3, you learned the components of an elevation drawing. In this assignment sheet you will learn more about the purposes of an elevation drawing and practice developing this type of drawing.

Types of elevation drawings

As noted in the definition above, there are two types of elevation drawings—exterior and interior. Exterior elevations are necessary to help a reader define the physical appearance of a structure from all of its various sides. Interior elevations are drawn when the floor plan cannot sufficiently convey the construction of a specific interior area of a structure. The following guidelines are presented to help you in completing an exterior or interior elevation drawing.

Guidelines for completing elevation drawings

- Normally, showing an exterior elevation view of a structure from all four sides (north, south, east, and west) is adequate. However, a complex structure may require more views.
- Elevation views are labelled in one of two ways—either by geographic relation (north elevation, south elevation, east elevation, or west elevation), or by functional relation (front elevation, rear elevation, left elevation, or right elevation).
- Elevations are normally drawn at the same scale as the completed floor plan of the structure.
- The completed floor plan of the structure is used as a guide for projecting all horizontal dimensions to the elevation view. Using this method, only height dimensions need to be added to complete the elevation drawing.

General sequence of steps used in developing an elevation drawing

1. Align the floor-plan drawing above the elevation-drawing sheet.

ASSIGNMENT SHEET 4

2. Establish the finished-floor line, grade line, and ceiling lines on the elevation drawing.

   NOTE: These exact dimensions will normally be obtained from the wall-section drawing, which you will study in Unit 5; however, these dimensions will be supplied to you in the exercise in this assignment sheet.

3. Project overall building width with two vertical lines from the floor plan.
4. Project any breaks in the wall down to the elevation drawing.
5. Establish location of roof lines.
6. Locate doors and windows by projecting their centerlines down from the floor plan.
7. Determine and draw in door and window heights as measured from the finished-floor line.
8. Darken visible object lines to complete view.
9. Add building-material symbols as required.
10. Label finished-grade line, floor line, ceiling line, top of doors, top of windows, and roof line.
11. Add any necessary notes and callouts to the drawing.
12. Complete title-block information.

Exercise

Directions

Using the floor plan you developed for the fire station in Assignment Sheet 3, the elevation information and guidelines provided below, and the sketch provided on the following page, develop on separate sheets of vellum the necessary elevation views for the fire station.

Elevation information:
Ceiling height—10′-0″
Top of structure—15′-0″
Top of roof—13′-9″
Top of doors—6′-8″
Top of windows—6′-8″
Grade line—1′-0″

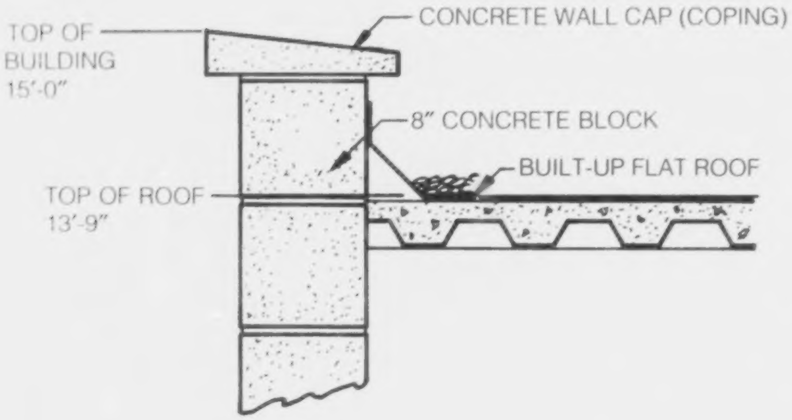
Guidelines:

- All dimensions are measured from the finished-floor line

ASSIGNMENT SHEET 4

- For better appearance, reduce the building height above the garage area by 1′-0″ to 2′-0″.

Rough sketch


TOP OF BUILDING 15′-0″
CONCRETE WALL CAP (COPING)
8″ CONCRETE BLOCK
BUILT-UP FLAT ROOF
TOP OF ROOF 13′-9″

INTRODUCTION TO WORKING DRAWINGS
UNIT 4

WRITTEN TEST

Name ______________________________ Score ______________

1. Match terms associated with working drawings to their correct definitions. Write the numbers on the blanks.

______a. Detailed set of written instructions that supplements the set of plans, describes equipment and materials used in the structure, and becomes part of the contract

______b. Drawing having many of the features of a photograph; drawn by the architect to interest clients

______c. Set of detailed drawings or plans drawn to scale by a drafter; shows all information and dimensions necessary to build or remodel a structure

______d. Drawing showing location and details about plumbing components and heating and air-conditioning units

______e. Drawing by a structural engineer or architect; may accompany working plans and give important information about structure's foundation, skeleton, and floor systems

______f. Listing or chart of parts, amounts, materials or products, and details

______g. Heavy broken line indicating plane at which a cross section is taken and the direction of viewing the object

______h. Line indicating dimension of a part or member

______i. Line extending from object line to dimension line

______j. Point where two lines meet

1. Schedule
2. Mechanical drawing
3. Presentation drawing
4. Specifications
5. Structural drawing
6. Working drawings
7. Line intersection
8. Cutting-plane line
9. Dimension line
10. Extension line

WRITTEN TEST

2. Describe types of drawings usually included in a set of working drawings. Write your answers on the blanks provided under each item below.

   a. Plot plan ____________________

   b. Foundation plan ____________________

   c. Floor plan ____________________

   d. Elevation ____________________

   e. Section ____________________

   f. Detail ____________________

WRITTEN TEST

g. Electrical floor plan ______________________________

____

____

____

h. Heating, ventilating, and air-conditioning floor plan ______________

____

____

____

____

i. Plumbing floor plan ______________________________

____

____

____

____

3. Match types of drawings in a set of working drawings to descriptions of the information found on those drawings. Write the numbers on the blanks provided. Descriptions continue on the next page.

______a. Location and dimensions of footings, grade beams, foundation walls, stem walls, piers, equipment footings, foundations

Location of anchor bolts

______b. Footings and foundations, including anchor bolts, reinforcing, control joints

Windows, exterior and interior doors, door frames, special openings

Roof, cornice, soffit, ceilings, eaves, gutters, downspouts

Fireplaces, chimneys

Staircases, stair assembly

______c. Location, dimensions, and elevation of structure on site

Finished and existing grade contours

1. Plot plan
2. Foundation plan
3. Floor plan
4. Elevation
5. Section
6. Detail

WRITTEN TEST

_______d. Grade lines

Floor height

Window and door types

Roof lines and slope, roofing material, vents, gravel stops, projection of eaves

Exterior finish materials and trim

Exterior dimensions

_______e. Building size drawn to scale

Location and thicknesses of interior partition walls

Dimensions and notes

Location and swing of doors

Location of stairways and elevators

Location of windows

_______f. Details of construction and information about stairs, walls, chimneys, or other parts of construction that may not show clearly on plan

Floor levels in relation to grade

Wall thicknesses at various locations

Anchors and reinforcing steel

4. Arrange in order the standard sequence of drawings in a set of working drawings. Write the correct sequence, numbers 1 through 5, on the blanks provided beside each of the items below.

_______a. Architectural drawings

_______b. Mechanial drawings

_______c. Structural drawings

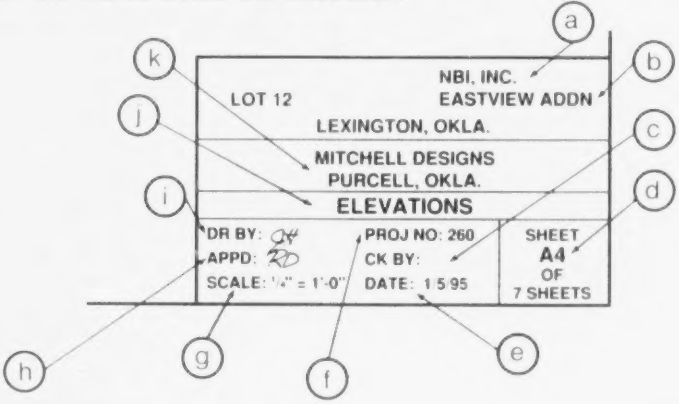
_______d. Cover sheet

_______e. Electrical drawings

WRITTEN TEST

5. Describe the drawing-identification system used in a set of working drawings. Write your answer on the blanks provided below.

6. Label the components of the title block shown in the illustration below. Write your answers on the blanks below the illustration.


a
b
c
d
e
f
g
h
i
j
k
NBI, INC.
LOT 12
EASTVIEW ADDN
LEXINGTON, OKLA.
MITCHELL DESIGNS
PURCELL, OKLA.
ELEVATIONS
DR BY: OH
APPD: RD
SCALE: ¼" = 1'-0"
PROJ NO: 260
CK BY:
DATE: 1/5/95
SHEET
A4
OF
7 SHEETS

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

i. ____________________

j. ____________________

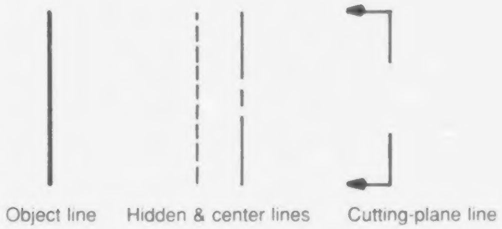
k. ____________________

WRITTEN TEST

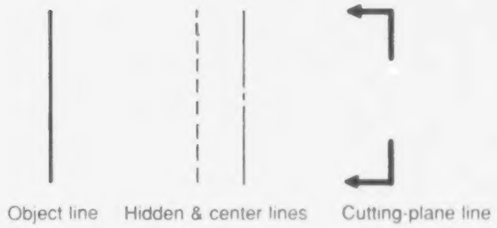
7. Identify standard architectural-linework techniques. For each of the following items, write an "X" in the blank with the drawing(s) that illustrates preferred methods of architectural linework.

a. **Line-weight contrast**

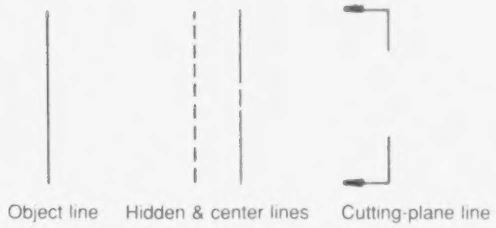
_____(1)


Object line
Hidden & center lines
Cutting-plane line

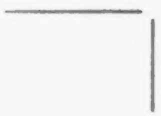
_____(2)

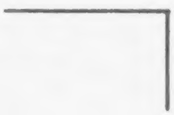

Object line
Hidden & center lines
Cutting-plane line

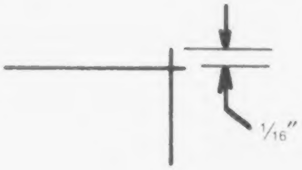
_____(3)


Object line
Hidden & center lines
Cutting-plane line

b. **Line intersections**







_____(1)

_____(2)

_____(3)

WRITTEN TEST

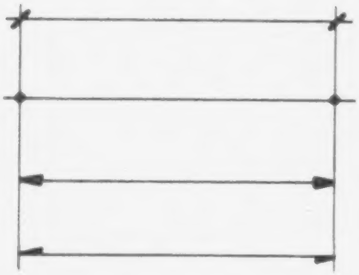
c. **Arrowheads**

______(1)

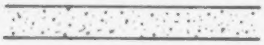
______(2)

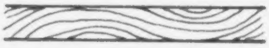
______(3)

______(4)

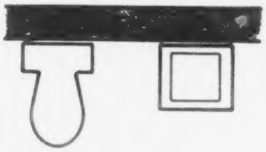


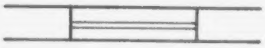
8. Label plan symbols used on floor plans. Write your answers on the blanks provided under each of the illustrations below.



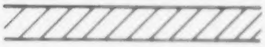


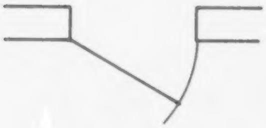
a. ______________________ b. ______________________





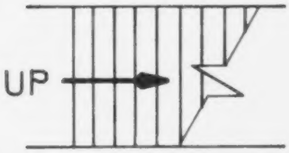
c. ______________________ d. ______________________

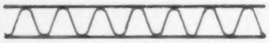




e. ______________________ f. ______________________

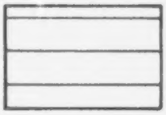
WRITTEN TEST

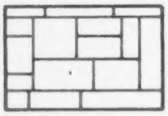




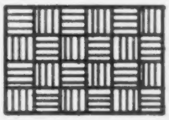
g. ______________________ h. ______________________

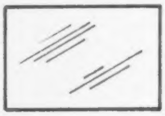
9. Label plan symbols used on elevation drawings. Write your answers on the blanks provided under each of the illustrations below.



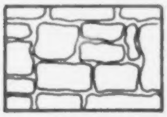


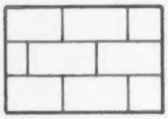
a. ______________________ b. ______________________





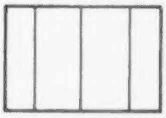
c. ______________________ d. ______________________

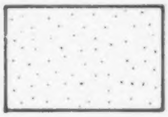




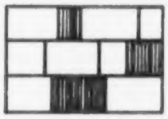
e. ______________________ f. ______________________

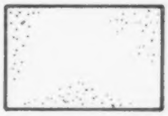
WRITTEN TEST



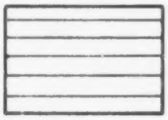


g. ______________________ h. ______________________





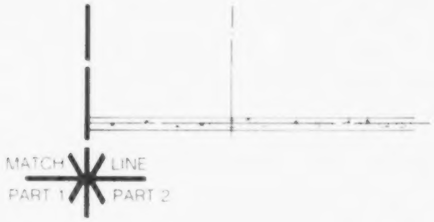
i. ______________________ j. ______________________

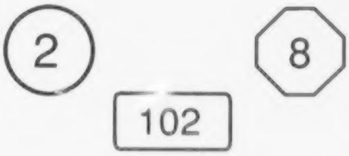


k. ______________________

10. Identify symbols and methods used in cross-referencing drawings. Write your answers on the blanks provided under each illustration.

Datum-target symbol
Plan-grid method
Match-line method
Schedule symbols
Key-plan method

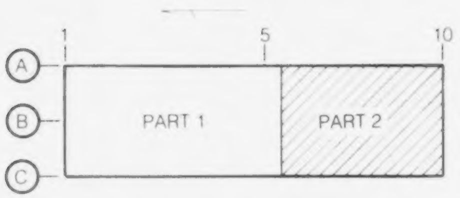


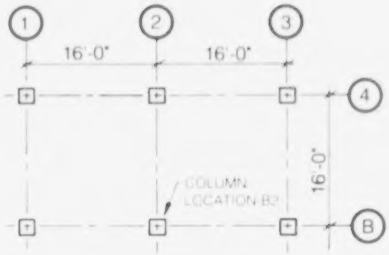


a. ______________________ b. ______________________

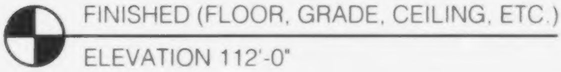
BEST COPY AVAILABLE

WRITTEN TEST


1
5
10
A
B
C
PART 1
PART 2


1
2
3
16'-0"
16'-0"
4
16'-0"
COLUMN LOCATION B2
B

c. ______________________ d. ______________________


FINISHED (FLOOR, GRADE, CEILING, ETC.)
ELEVATION 112'-0"

e. ______________________

11. Label standard headings presented in drawing schedules. Label the headings on each of the schedules shown in the tables below. Write your answers on the blanks provided under each table.

a. **Column and beam schedule**

① ② ③ ④ ⑤

Mk	**No**	**Description**	**Length**	**Remarks**
1	4	3½" steel-pipe standard column w/plates	7'-6"	—
2	1	W8 × 31 wide flange	12'-0"	To be bolted to W10 × 24 below
3	12	C12 × 20.7 steel channels	9'-0"	—

(1) ______________________

(2) ______________________

(3) ______________________

(4) ______________________

(5) ______________________

WRITTEN TEST

b. **Window schedule**

① Sym	② Size	③ Type	④ Mfgr & catalog no	⑤ Remarks	⑥ Glass
A	6'-0" × 4'-0"	Fixed	"E-Z set" 7248C	Alum w/plastic screens	Thermopane
B	8'-0" × 4'-0"	DO	DO 9648C	DO	DO
C	10'-0" × 3'-0"	DO	DO 12036C	DO	DO
D	2'-0" × 4'-0"	DO	DO 2448M	Wood trim	¼" PP
E	6'-0" × 4'-0"	DO	DO 7248M	DO	DO
F	7'-0" × 4'-0"	DO	DO 8448C	Alum w/plastic screens	Thermopane
G	6'-0" × 3'-0"	DO	DO 7236C		DO

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

(5) ______________________________

(6) ______________________________

c. **Footing schedule**

① Mk	② A	③ B	④ C	⑤ Elev	⑥ Reinf	⑦ Remarks
1	8″	1′-4″	8″	93.4′	2 #4	Reinf bars each way
2	10″	1′-6″	8″	93.4′	2 #4	Reinf bars each way
3	8″	1′-4″	8″	97.4′	None	—

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

(5) ______________________________

(6) ______________________________

(7) ______________________________

WRITTEN TEST

d. **Electrical schedule**

①	②	③	④	⑤	⑥
***Location**	**Symbol**	**No**	**Watt/ amp**	**Description**	**Manuf/cat no**
Lobby	⊜ ⊙$_E$	2 2	100 100	Duplex outlet Flush ceiling	Seymour #41-1 DO #40-2
Conference room	⊜ ⊙$_B$	6 2	100 60	Duplex outlet Wall valance	General #1606 DO
Bathroom #1	⊜ ⊙$_A$	2 2	100 100	Duplex outlet Ceiling mount	Seymour #41-1 DO #41-3

*Mark number may be indicated

(1) ____________________

(2) ____________________

(3) ____________________

(4) ____________________

(5) ____________________

(6) ____________________

WRITTEN TEST

e. **Door schedule**

① ② ③ ④ ⑤ ⑥ ⑦

Sym	Size	Mfgr & catalog no		Remarks	Material	Thk	Type
1	3′-0″ × 6′-8″	Phillips	Housemart	3 coats ext trim paint	Metal	1¾″	Solid
2	3′-0″ × 6′-8″	DO	M-1 M-5	DO	DO	DO	DO
3	2′-0″ × 6′-8″	DO	M-91	DO	DO	DO	DO
4	2′-0″ × 6′-8″	DO	A-4	Stain & lacq finish	Birch	1⅜″	Hollow core
5	2′-0″ × 6′-8″	DO	A-10	DO	DO	DO	DO
6	2′-0″ × 6′-8″	DO	B-17	DO	Pine	DO	Bifold
7	3′-0″ × 6′-8″	DO	A-5	DO	Birch	DO	Solid core
8	3′-0″ × 6′-8″	DO	A-17	DO	DO	DO	Hollow core
9	2′-6″ × 6′-8″	DO	A-21	DO	DO	DO	DO
10	2′-10″ × 6′-8″	DO	D-7	DO	DO	DO	DO
11	2′-6″ × 6′-8″	DO	D-4	DO	DO	DO	DO

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

(5) ______________________________

(6) ______________________________

(7) ______________________________

WRITTEN TEST

f. Room finish schedule

①	②	③		④		⑤								⑥			⑦	⑧
Mark no	Room	Floor		Base		Walls								Ceiling			Materials	Paint & finish
						N		E		S		W						
		M	F	M	F	M	F	M	F	M	F	M	F	M	F	Ht		
101	Office	1	A	4	D	6	C	6	C	7	C	7	C	7	D	8'-0"	1 Carpet (NIC)	A Non req'd
102	Storage	2	A	4	E	7	D	6	D	7	D	7	D	7	D	8'-0"	2 Vinyl sheet	B Wall paper (NIC)
103	Lab	5	A	4	E	7	D	6	D	7	D	7	D	7	D	8'-0"	3 Ceramic tile	C Vinyl wall covering (NIC)
104	Dentist's office	1	A	4	F	8	F	6	A	8	F	8	F	7	H	8'-0"	4 Wood base	D Semi-gloss enamel
105	Bath - dentist	3	A	4	F	7	B	6	B	7	B	7	B	7	H	8'-0"	5 Vinyl base	E Flat wall latex
106	Storage	1	A	4	E	7	D	7	D	7	D	7	D	7	D	8'-0"	6 Concrete bare	F Stain varnish
107	X-ray lab	2	A	5	A	7	D	7	D	7	D	7	D	7	A	8'-0"	7 Gypsum walled	G Semi-transp stain
108	Storage	6	A	4	E	7	A	6	A	7	A	7	A	7	A	Varies	8 Wood paneling	H Accoustical texture

(NIC) = Not in contract M = Material F = Finish

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

(5) ______________________________

(6) ______________________________

(7) ______________________________

(8) ______________________________

SECTION AND DETAIL DRAWINGS
UNIT 5

UNIT OBJECTIVE

After completing this unit, the student should be able to define and draw common types of building section and detail drawings. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with section and detail drawings to their correct definitions.
2. Label architectural methods used in drawing cutting-plane lines.
3. State definitions of the terms *detail drawing* and *section drawing.*
4. Match types of architectural section drawings to their correct descriptions.
5. Identify symbols used on section drawings.
6. Match types of architectural detail drawings to their correct descriptions.
7. List stairway features described on stairway details.
8. Label reference methods used for sections and details.
9. Interpret symbols used in referencing sections and details.
10. Develop a footing detail. (Assignment Sheet 1)
11. Develop a sill detail. (Assignment Sheet 2)
12. Develop a cornice detail. (Assignment Sheet 3)
13. Select necessary section views from a floor plan. (Assignment Sheet 4)
14. Develop a longitudinal section. (Assignment Sheet 5)
15. Develop a wall-section drawing. (Assignment Sheet 6)

SECTION AND DETAIL DRAWINGS
UNIT 5

SUGGESTED ACTIVITIES

Preparation

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.
- Review teaching suggestions given in the "Delivery and Application" section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.
- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section.
- Make transparency masters as required.
- Prepare classroom and lab. Put up posters, charts, and signs; display articles and other references related to the objectives of this unit.

Delivery and Application

Unit introduction

- Provide students with objective sheet. Discuss unit and specific objectives.
- Hold a class discussion explaining the function of section and detail drawings in a set of architectural plans. Explain that these drawings provide the builder with the specific information concerning building materials and exact construction methods to be used. Discuss how detail drawings and section drawings are vital to determine cost estimates for a project.
- Provide students with information sheet.

Objective 1 Match terms associated with section and detail drawings to their correct definitions.

- Show examples that illustrate terms and make examples available in the classroom.
- Use Figure 1 to illustrate your discussion of the terms *cutting-plane line*, *head*, *jamb*, and *sill*.
- Use Figure 2 to illustrate your discussion of the terms *tread*, *riser*, and *nosing*.

SUGGESTED ACTIVITIES

Objective 2 Label architectural methods used in drawing cutting-plane lines.

- Read to students the note introducing the objective. Show examples of floor plans filled with dimensions and linework and the corresponding placement of cutting-plane lines.

- Use the figures in the objective to illustrate your discussion of the differences between architectural methods and standard practices. Also draw other examples on the chalkboard to illustrate these differences.

Objective 3 State definitions of the terms *detail drawing* and *section drawing*.

- Review with students fundamental concepts of section and detail drawings learned in Unit 4, "Introduction to Working Drawings." Have students study the section and detail drawings presented in the working drawings of day-care center that accompany this publication.

Objective 4 Match types of architectural section drawings to their correct descriptions.

- Read to students the note introducing the objective. Then discuss with students the common types of section drawings presented in the objective. Use Transparencies 1 and 2 and the figures presented in the objective to illustrate your discussion.

- Emphasize to students the importance of producing accurate and detailed section drawings, as it is these drawings that are used most during construction.

Objective 5 Identify symbols used on section drawings.

- On the chalkboard, draw for students the various section symbols illustrated in the objective. Discuss the correct procedure for drawing each symbol and the meaning of each symbol. Illustrate how symbols were developed in an attempt to graphically connect the actual physical appearance of the material with the symbol that was developed.

Objective 6 Match types of architectural detail drawings to their correct descriptions.

Objective 7 List stairway features described on stairway details.

- Read to students the note introducing Objective 6. Then further explain the concept of a detail drawing.

SUGGESTED ACTIVITIES

- Explain each type of detail shown in the objective. Show each type of drawing on the chalkboard or use Transparencies 3 through 7 and the figures in the objective to illustrate your discussion.
- Discuss with students the features of a stairway described on stairway details. Again, use Transparency 7 and Figure 13 in Objective 6 to illustrate your discussion.
- Arrange a visit to a commercial construction site. Have students identify various components of the structure under construction as well as visually connect what they identify with the building details they have seen drawn in a set of plans (i.e., footing, cornice, stairway components).

Objective 8 Label reference methods used for sections and details.

Objective 9 Interpret symbols used in referencing sections and details.

- Read to students the note introducing Objective 8. Reemphasize the importance of reference callouts.
- Draw an example of the section method on the chalkboard and explain the various callouts. Then, draw an example of the detail method on the chalkboard and explain the various callouts. Using these two examples, discuss the similarities between the two methods.
- Use Transparency 8 to discuss the sequence and use of reference methods in an actual drawing application.

Assignment Sheets 1 through 6

- Read with students Student Supplement 1, "Drawing Scales Used for Sections and Details." Discuss the advantages and disadvantages of using various drawing scales (less drawing sheets required versus scales drawn too small to show construction detail).
- Discuss and explain how different scales would affect the drawing area being used on a single sheet of paper.
- Have students select an architectural detail drawing (or assign a detail drawing) and draw it at three different scales. Discuss the results, such as which was the best scale to use and why.
- Hand out Assignment Sheets 1 through 3. Read the introductions to the assignments, and explain the information and sketches presented in the assignment sheets. Answer any student questions, and then have students complete Assignment Sheets 1 through 3.

SUGGESTED ACTIVITIES

- Hand out Assignment Sheets 4 through 6. Explain that in these assignment sheets the students will continue to develop drawings of the proposed fire station that they began in Unit 4, Assignment Sheets 3 and 4.
- Read the introductions and directions to the exercises in the assignment sheets. Answer any student questions, and then have students complete Assignment Sheets 4 through 6.

Evaluation

- Give written test.
- Compile written-test and assignment-sheet scores on Unit Evaluation Form.
- Reteach and retest as required.

Suggested Resources

Resources used in developing unit

Print media

- Muller, Edward J. *Architectural Drawing and Light Construction*. Englewood Cliffs, New Jersey: Prentice-Hall, 1985.
- International Conference of Building Officials (ICBO). *Uniform Building Code*. Whittier, California: ICBO, 1988.
- Spence, William P. *Architecture: Design, Engineering, Drawing*. Bloomington, Illinois: Glencoe, Bennett & McKnight, 1985.

Additional resources

Print media

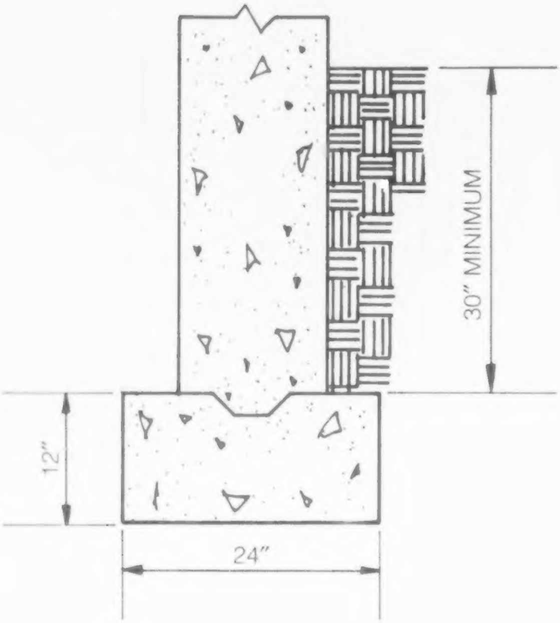
- Harris, Cyril M. *Dictionary of Architecture and Construction*. New York: McGraw-Hill, 1985.
- Lewis, Jack R. *Architectural Draftsman Reference Handbook*. Englewood Cliffs, New Jersey: Prentice-Hall, 1982.
- Ramsey, Charles. *Architectural Graphic Standards*, 8th ed. New York: Wiley and Sons, 1988.

SECTION AND DETAIL DRAWINGS
UNIT 5

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

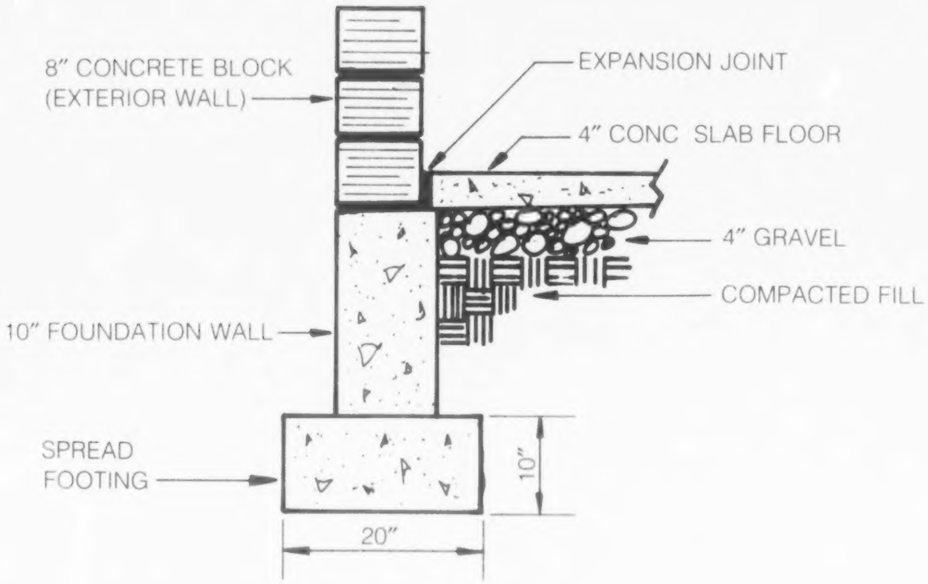
Student drawing should be similar to the sketch shown below. Instructor should check the drawing for proper symbology, proper scale, correct dimensions, keyway shown, and grade-line placement.



ANSWERS TO ASSIGNMENT SHEETS

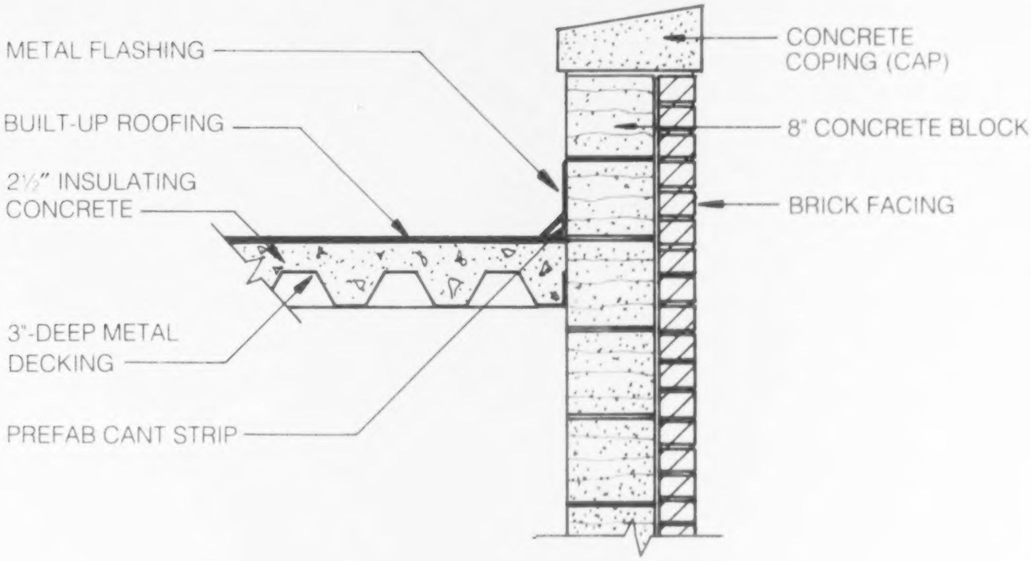
Assignment Sheet 2

Student drawing should be similar to the sketch shown below. Instructor should check the drawing for proper symbology, proper scale, correct dimensions, keyway shown, and grade-line placement.


8" CONCRETE BLOCK (EXTERIOR WALL)
EXPANSION JOINT
4" CONC SLAB FLOOR
4" GRAVEL
COMPACTED FILL
10" FOUNDATION WALL
SPREAD FOOTING
10"
20"

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 3	Student drawing should be similar to the sketch shown below. Instructor should check the drawing for proper symbology, proper scale, correct dimensions, keyway shown, and grade-line placement.


METAL FLASHING
BUILT-UP ROOFING
2½" INSULATING CONCRETE
3"-DEEP METAL DECKING
PREFAB CANT STRIP
CONCRETE COPING (CAP)
8" CONCRETE BLOCK
BRICK FACING

Assignment Sheet 4	Evaluated to the satisfaction of the instructor.
Assignment Sheet 5	Evaluated to the satisfaction of the instructor.
Assignment Sheet 6	Evaluated to the satisfaction of the instructor.

SECTION AND DETAIL DRAWINGS
UNIT 5

ANSWERS TO WRITTEN TEST

1. a. 5
   b. 9
   c. 6
   d. 1
   e. 8
   f. 4
   g. 7
   h. 3
   i. 2

2. a. Complete-building offset method
   b. Complete-building section method
   c. Wall-section method

3. a. Drawing of an area of construction that has been enlarged to show specific materials dimensions and construction methods
   b. Drawing that shows a portion of a structure as it would appear on the interior after a cutting plane has passed through it

4. a. 3
   b. 1
   c. 2

5. a. Earth
   b. Marble
   c. Ceramic tile
   d. Rock
   e. Sand
   f. Concrete
   g. Cut slate
   h. Flagstone
   i. Cinders
   j. Aggregate
   k. Steel
   l. Wood

6. a. 3
   b. 7
   c. 1
   d. 4
   e. 5
   f. 6
   g. 2
   h. 8

7. Answer should include any 6 of the following

   a. Total rise
   b. Total run
   c. Riser height
   d. Tread length
   e. Tread nosing
   f. Headroom clearance
   g. Handrail height
   h. Landing size
   i. All material callouts

8. a. Section method
   b. Detail method

ANSWERS TO WRITTEN TEST

9. a.
    - (1) Symbol indicating direction of sight
    - (2) Number indicating sheet number where section view is to be shown
    - (3) Number indicating sheet number from which section is taken
    - (4) Section identification letter

   b.
    - (1) Symbol indicating area to be enlarged
    - (2) Number indicating sheet number from which detail is taken
    - (3) Number indicating sheet number where detail is to be shown
    - (4) Number indicating detail number

SECTION AND DETAIL DRAWINGS
UNIT 5

UNIT EVALUATION FORM

Student name ______________________________ Unit rating ____________

Assignment sheet ratings

Assignment Sheet 1—Develop a Footing Detail Rating ____________

Comments: ______________________________

____

Assignment Sheet 2—Develop a Sill Detail Rating ____________

Comments: ______________________________

____

Assignment Sheet 3—Develop a Cornice Detail Rating ____________

Comments: ______________________________

____

Assignment Sheet 4—Select Necessary Section Views from a Floor Plan Rating ____________

Comments: ______________________________

____

Assignment Sheet 5—Develop a Longitudinal Section Rating ____________

Comments: ______________________________

____

Assignment Sheet 6—Develop a Wall-Section Drawing Rating ____________

Comments: ______________________________

____

UNIT EVALUATION FORM

Written test scores

Pretest ____________ Other ____________

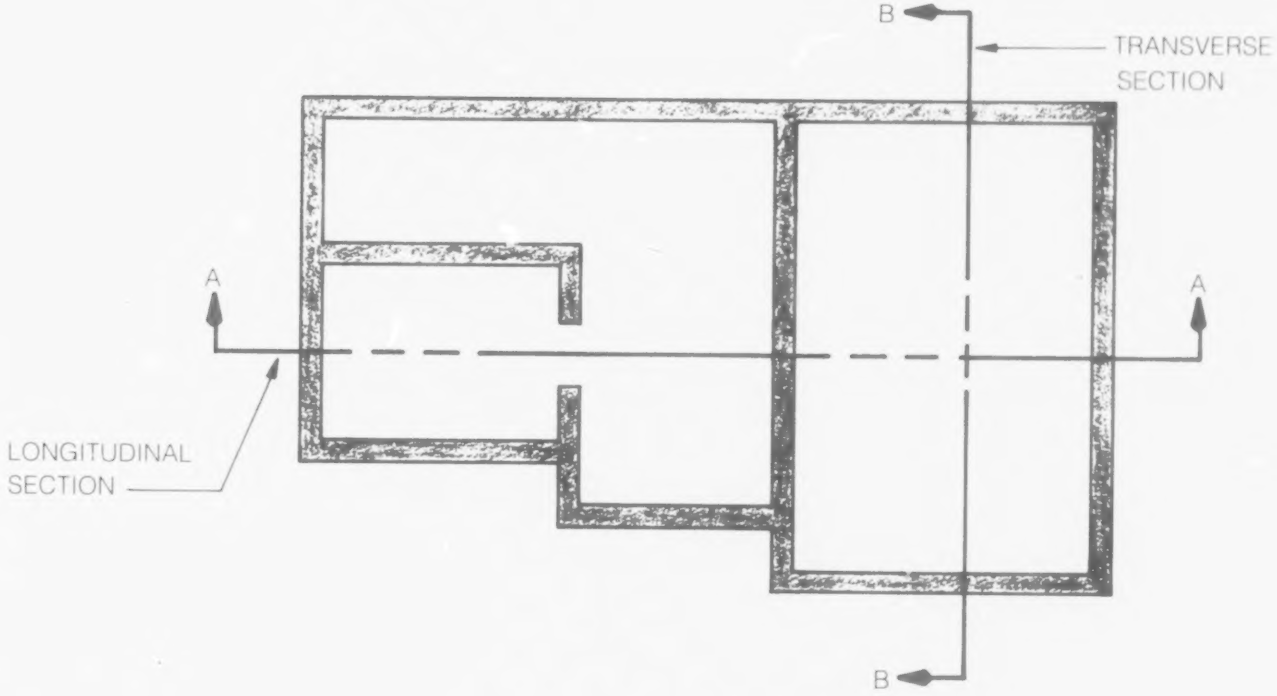
Posttest ____________

Instructor signature ____ Date ____________

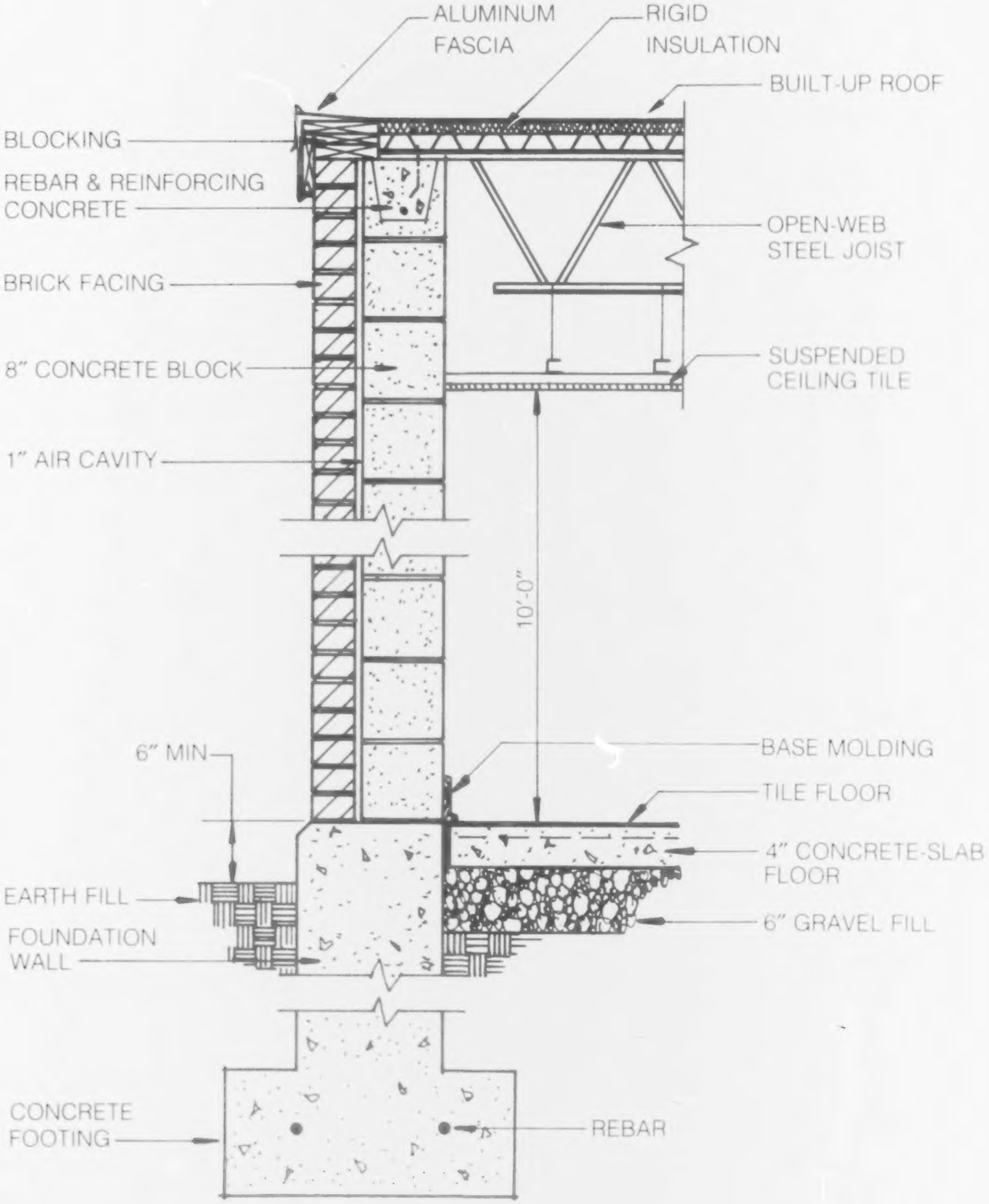
Student signature ____ Date ____________

Duplication of this form is permitted.

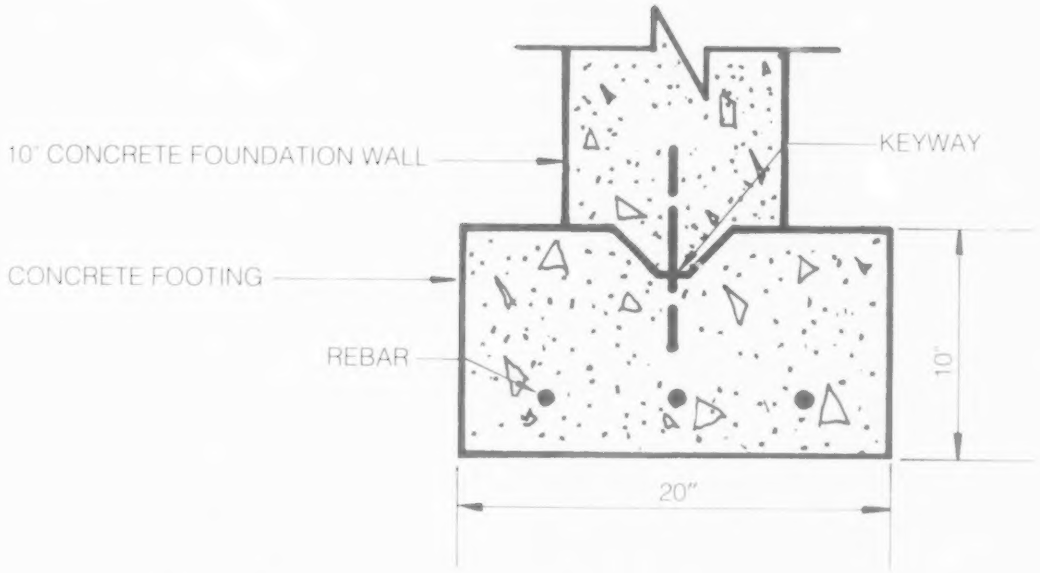
Longitudinal and Transverse Sections


B
TRANSVERSE SECTION
A
A
LONGITUDINAL SECTION
B

Wall Section


ALUMINUM FASCIA
RIGID INSULATION
BUILT-UP ROOF
BLOCKING
REBAR & REINFORCING CONCRETE
OPEN-WEB STEEL JOIST
BRICK FACING
8" CONCRETE BLOCK
SUSPENDED CEILING TILE
1" AIR CAVITY
10'-0"
6" MIN
BASE MOLDING
TILE FLOOR
4" CONCRETE-SLAB FLOOR
EARTH FILL
FOUNDATION WALL
6" GRAVEL FILL
CONCRETE FOOTING
REBAR

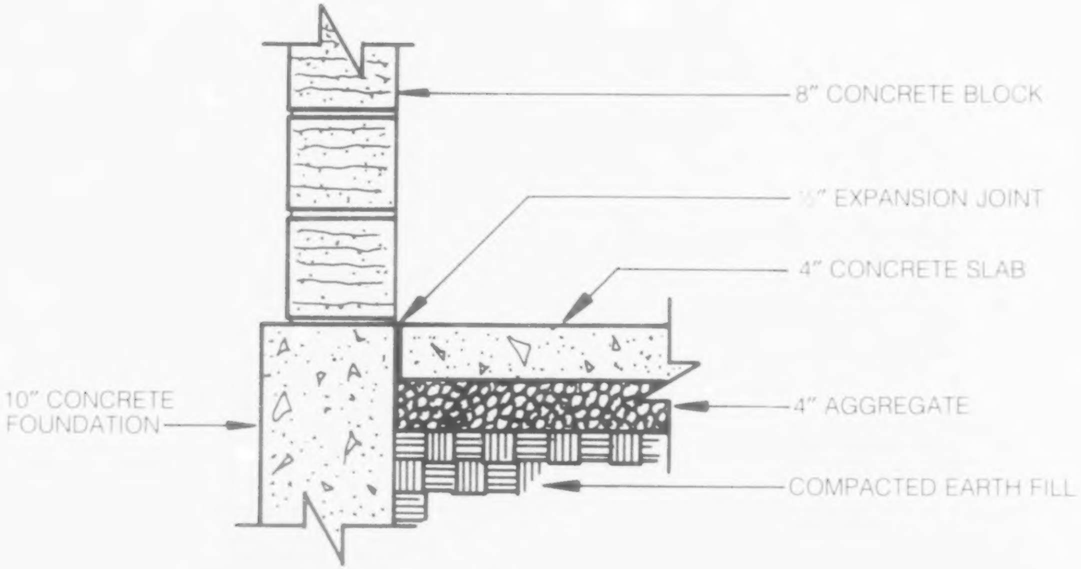
Footing Detail


10" CONCRETE FOUNDATION WALL
KEYWAY
CONCRETE FOOTING
REBAR
10"
20"

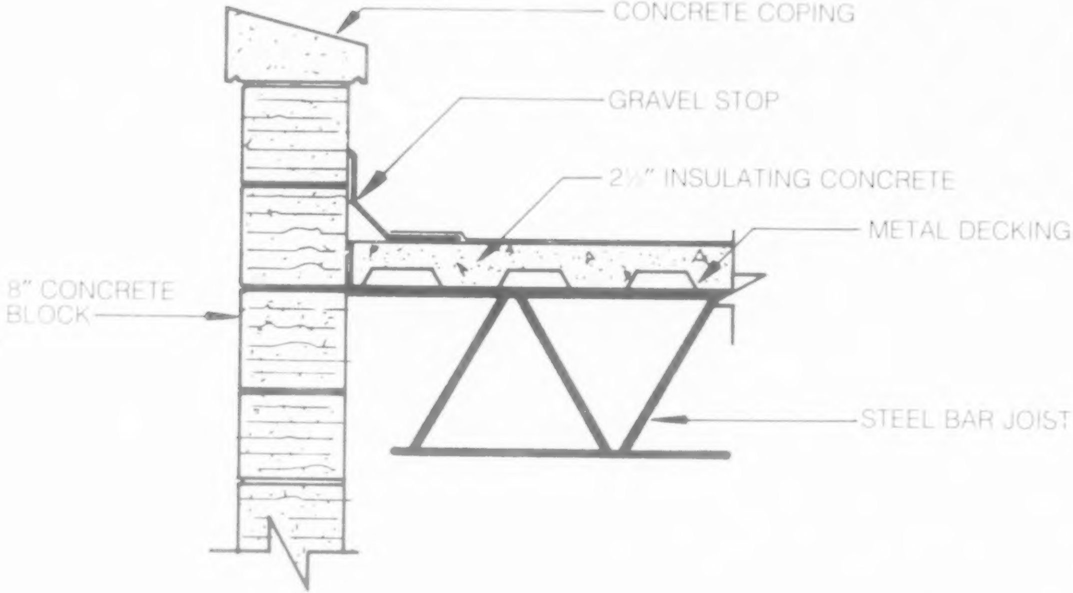
TM 3

AD-291

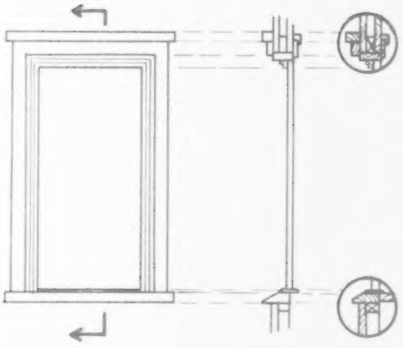
Sill Detail

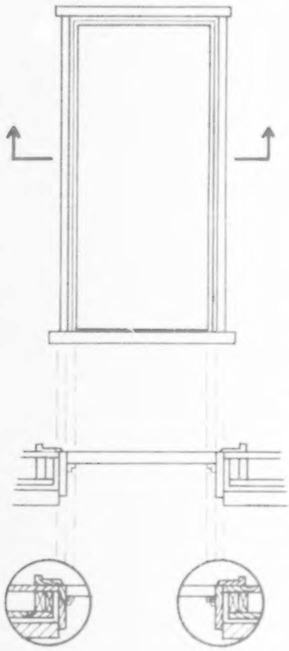

8" CONCRETE BLOCK
½" EXPANSION JOINT
4" CONCRETE SLAB
10" CONCRETE FOUNDATION
4" AGGREGATE
COMPACTED EARTH FILL

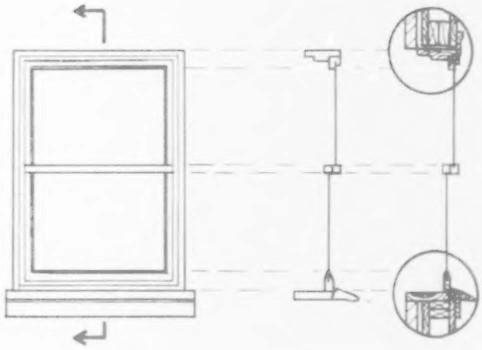
Cornice Detail

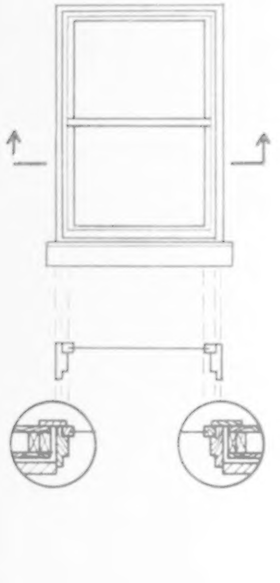

CONCRETE COPING
GRAVEL STOP
2½" INSULATING CONCRETE
METAL DECKING
8" CONCRETE BLOCK
STEEL BAR JOIST

Door and Window Details

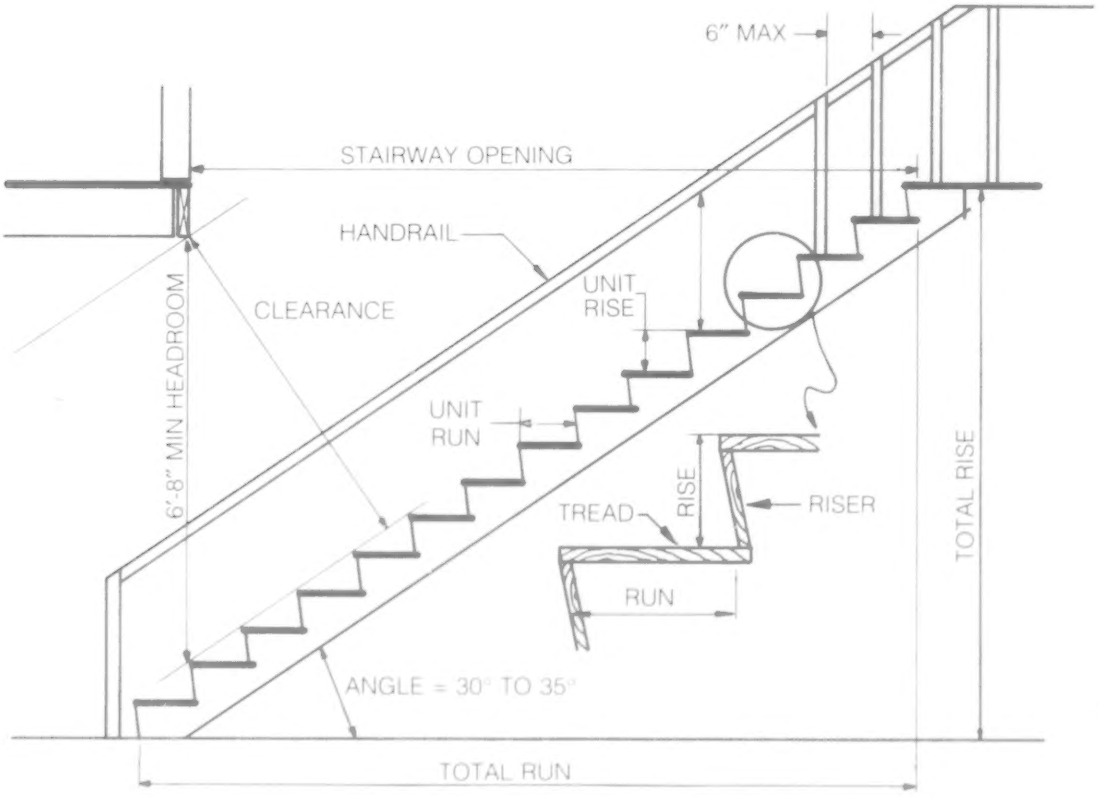




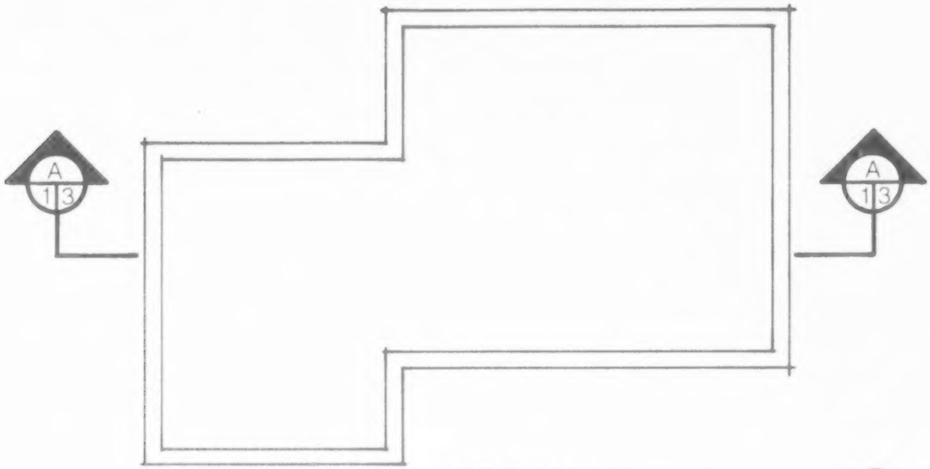




Stairway Detail

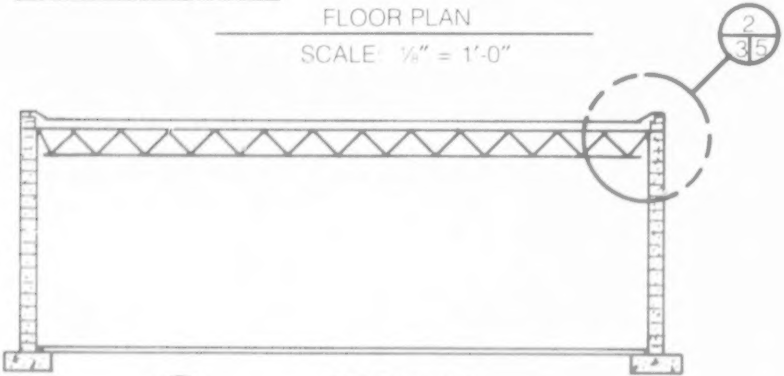

6" MAX
STAIRWAY OPENING
HANDRAIL
UNIT RISE
CLEARANCE
6'-8" MIN HEADROOM
UNIT RUN
RISE
RISER
TREAD
RUN
TOTAL RISE
ANGLE = 30° TO 35°
TOTAL RUN

Use of Referencing Symbols



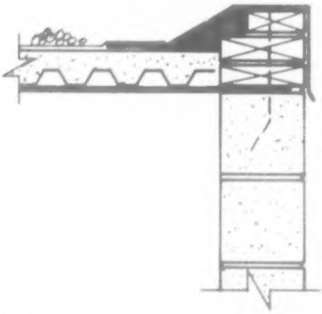
FLOOR PLAN

SCALE: ⅛" = 1'-0"



SECTION A-A

SCALE: ⅛" = 1'-0"



CORNICE SECTION

SCALE: 1½" = 1'-0"

SECTION AND DETAIL DRAWINGS
UNIT 5

INFORMATION SHEET

1. **Terms and definitions associated with section and detail drawings**

   a. **Cornice**—Exterior structural trim along intersection of roof and top of wall; includes all framing and trim members

   b. **Cutting-plane line** (see Figure 1)—Heavy broken line on a drawing with perpendicular arrows and letters or numbers at each end; used to indicate the plane at which a cross section is taken and the direction of viewing the object

   c. **Footing**—Section of foundation that supports and distributes structural loads directly to the soil

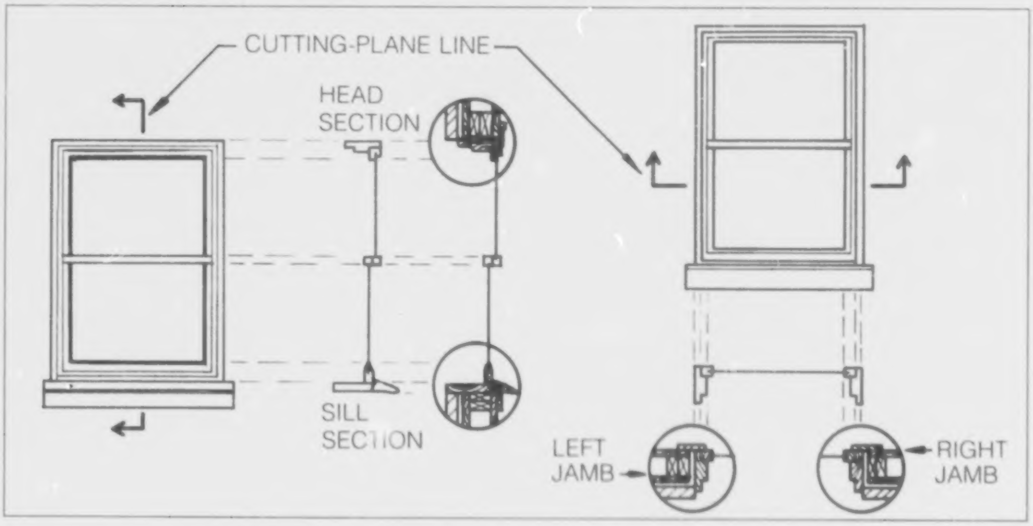
   d. **Head** (see Figure 1)—Any horizontal upper member of a framed unit

   EXAMPLES: Door head, window head

   e. **Jamb** (Figure 1)—Any vertical member on either side of a framed unit

   EXAMPLES: Door jamb, window jamb

   FIGURE 1



   f. **Nosing** (tread nosing) (see Figure 2)—Prominent extension of a stairway tread beyond the vertical face (riser) of a stair

   g. **Riser** (see Figure 2)—Vertical face of a stair from top to bottom

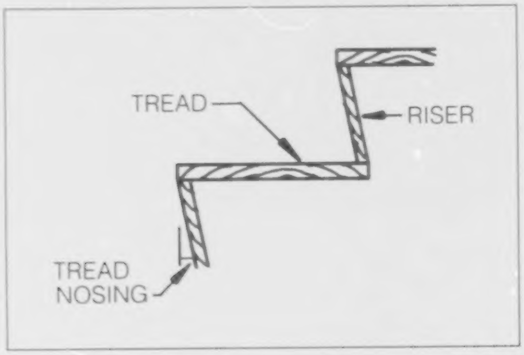
INFORMATION SHEET

h. **Sill** (see Figure 1)—Any horizontal bottom member of a framed unit

EXAMPLES: Door sill, window sill

i. **Tread** (Figure 2)—Horizontal surface of a stair, including nosing

FIGURE 2



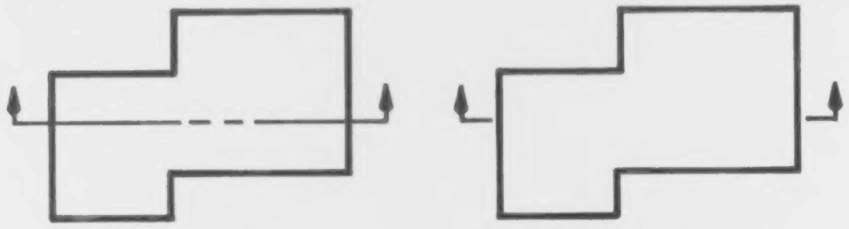
2. **Architectural methods used in drawing cutting-plane lines**

NOTE: The methods a drafter uses in drawing cutting-plane lines for architectural drawings differ from standard drafting practices. Architectural drawings contain a great deal of information. If an architectural drafter were to use the standard methods of drawing cutting planes in his or her drawings, the lines would often interfere with the rest of the drawing, making it difficult to read. Therefore, the following accepted methods have been developed for drafters to use on architectural drawings.

a. **Complete-building section method** (Figure 3)

NOTE: In using the complete-building section method, the drafter indicates only the cutting-plane extremes; the cutting-plane line is assumed to be straight.

FIGURE 3



(a) Standard method

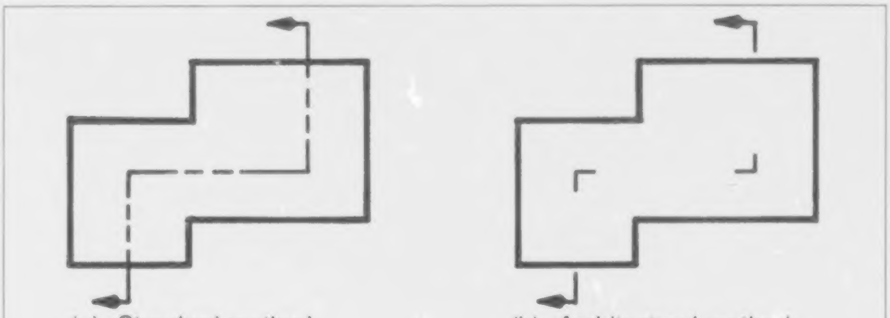
(b) Architectural method

INFORMATION SHEET

b. **Complete-building offset method** (Figure 4)

NOTE: In using the complete-building offset method, the drafter indicates only the cutting-plane extremes and the offset corners.

FIGURE 4

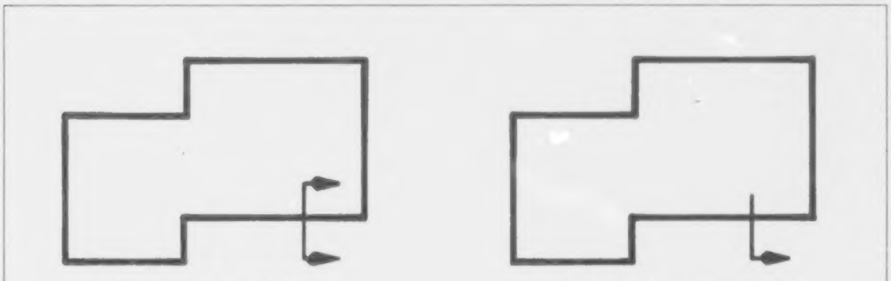


(a) Standard method (b) Architectural method

c. **Wall-section method** (Figure 5)

NOTE: In using the wall-section method, the drafter draws only the outside arrow of the cutting-plane arrows used on standard drawings.

FIGURE 5



(a) Standard method (b) Architectural method

3. **Definitions of the terms *detail drawing* and *section drawing***

a. **Detail drawing**—Drawing of an area of construction that has been enlarged to show specific materials dimensions and construction methods

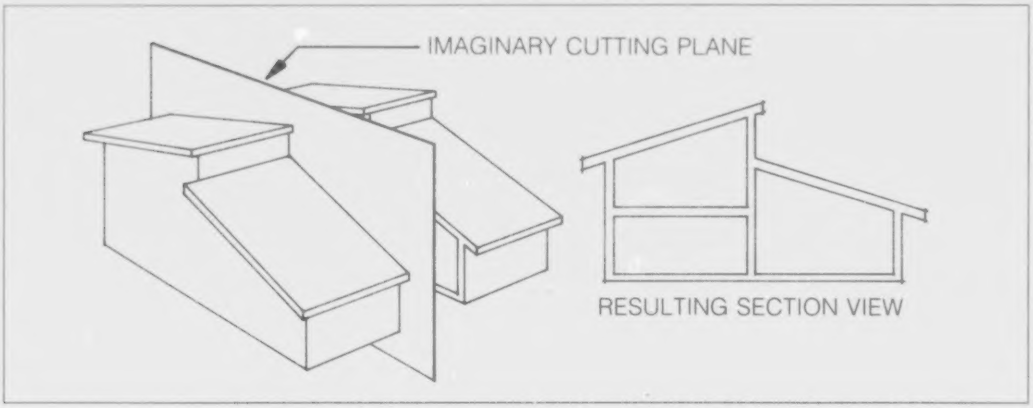
b. **Section drawing**—Drawing that shows a portion of a structure as it would appear on the interior after a cutting plane has passed through it

INFORMATION SHEET

4. Types of architectural section drawings and their descriptions

NOTE: In order to show the internal construction of a structure, a drafter must develop sectional views using cutting-plane lines placed through various portions of a floor plan and accompanying elevation drawings. See Figure 6. The cutting-plane lines are placed only after careful consideration as to what locations will best show all of the different construction-material methods to be used. Listed below are some of the most common and necessary section views to be developed in a set of drawings.

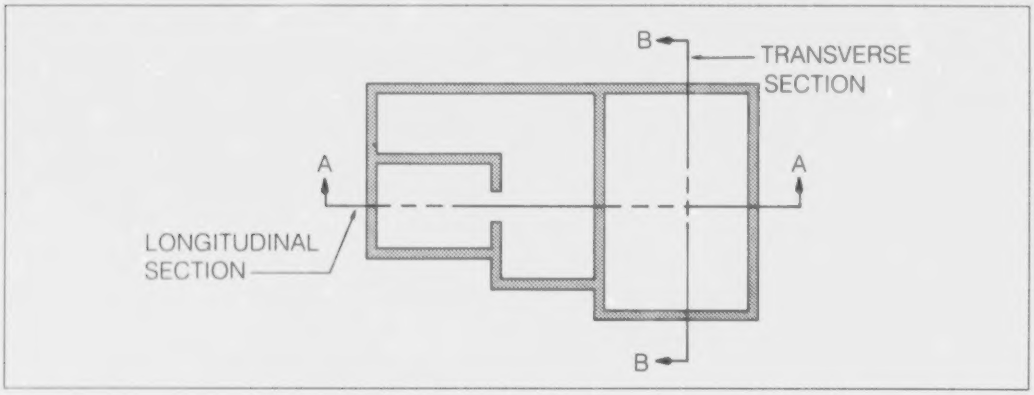
FIGURE 6



a. **Longitudinal section** (see Figure 7)—Complete-building section view in which cutting plane runs through entire length of structure

b. **Transverse section** (Figure 7)—Complete-building section view in which cutting plane runs perpendicular to longitudinal cutting plane (the narrow width of the structure)

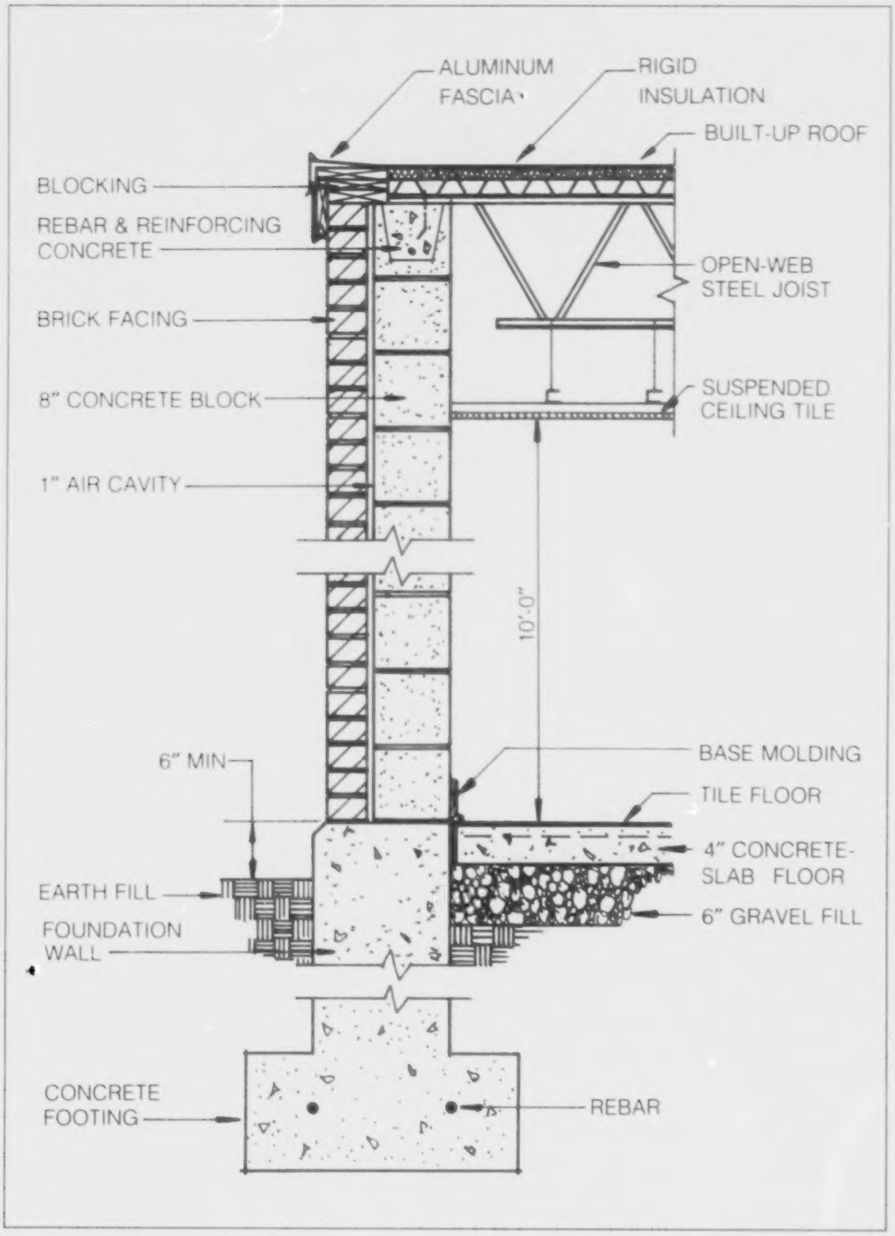
FIGURE 7



INFORMATION SHEET

c. **Wall section** (Figure 8)—Section view in which cutting plane runs through a wall from the top of the roof to the bottom of the foundation

FIGURE 8: Complete wall section


ALUMINUM FASCIA
RIGID INSULATION
BUILT-UP ROOF
BLOCKING
REBAR & REINFORCING CONCRETE
OPEN-WEB STEEL JOIST
BRICK FACING
8" CONCRETE BLOCK
SUSPENDED CEILING TILE
1" AIR CAVITY
10'-0"
BASE MOLDING
6" MIN
TILE FLOOR
4" CONCRETE-SLAB FLOOR
EARTH FILL
6" GRAVEL FILL
FOUNDATION WALL
CONCRETE FOOTING
REBAR

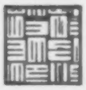
INFORMATION SHEET

5. **Symbols used on section drawings** (Table 1)

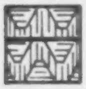
NOTE: Symbols used to define building materials that have been cut through are called *section symbols*. Each symbol is a specific representation for a given building material. However, since a floor-plan drawing is actually a horizontal section, many of the section symbols are the same as those you learned for floor-plan drawings.

TABLE 1: Section-drawing symbols

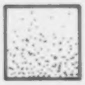
Earth



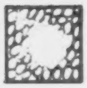
Rock



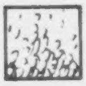
Sand



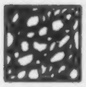
Gravel



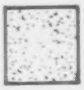
Cinders



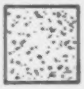
Aggregate



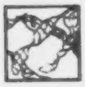
Cut stone—ashlar



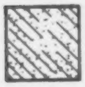
Cut stone—rough



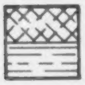
Marble



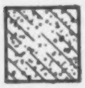
Flagstone



Cut slate



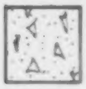
Random rubble



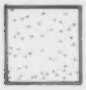
INFORMATION SHEET

TABLE 1 (cont.)

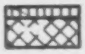
Concrete



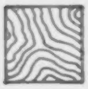
Limestone



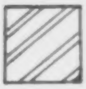
Ceramic tile



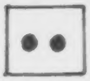
Wood



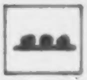
Steel



Steel reinforcing bars



Welded wire mesh

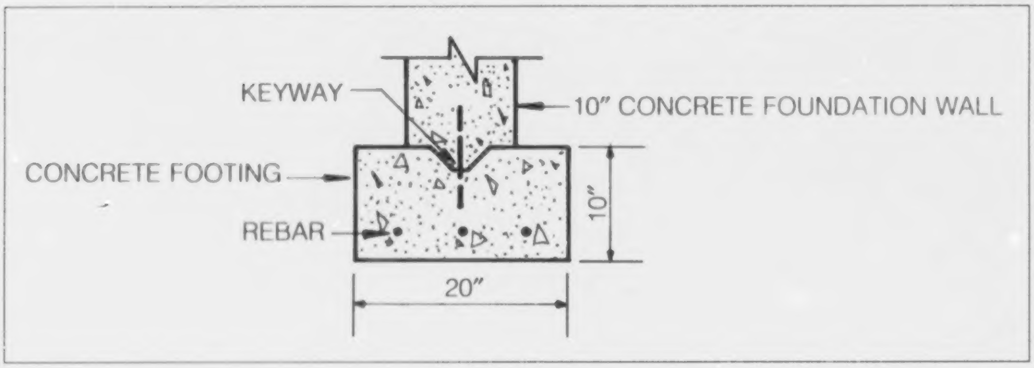


6. **Types of architectural detail drawings and their descriptions**

NOTE: Because floor plans, elevations, and wall sections are drawn at relatively small scales, specifics of construction, such as building materials, construction methods, the relationships among materials used, and specific locations and sizes, cannot be shown. Larger-scale drawings, called *details*, are therefore drawn to provide a reader with these specifics of construction. Shown below are some of the most common areas that require details to be developed.

a. **Footing detail** (foundation detail) (Figure 9)—Detail drawn to indicate dimensional information and material callouts concerning structure's foundation

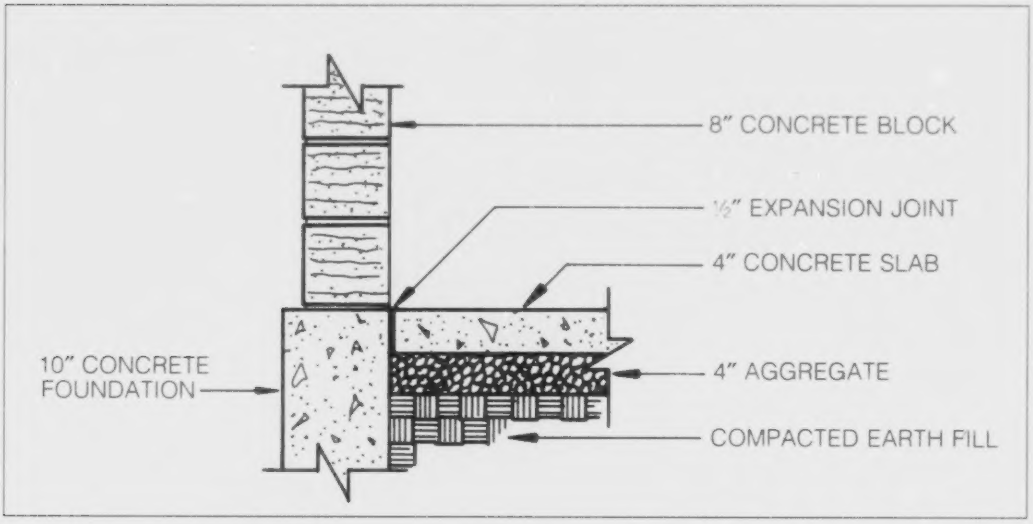
FIGURE 9



INFORMATION SHEET

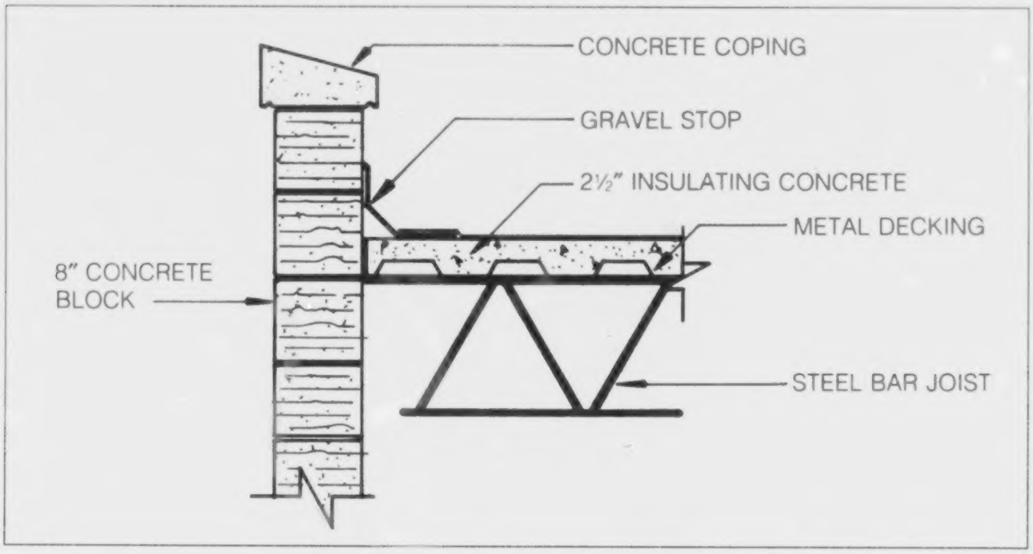
b. **Sill detail** (Figure 10)—Detail drawn to shown how structure's foundation wall connects to exterior outside wall and floor system

FIGURE 10


8" CONCRETE BLOCK
½" EXPANSION JOINT
4" CONCRETE SLAB
10" CONCRETE FOUNDATION
4" AGGREGATE
COMPACTED EARTH FILL

c. **Cornice detail** (Figure 11)—Detail drawn to show how exterior wall intersects structure's roofing system and any roof overhang that occurs at that intersection

FIGURE 11


CONCRETE COPING
GRAVEL STOP
2½" INSULATING CONCRETE
METAL DECKING
8" CONCRETE BLOCK
STEEL BAR JOIST

INFORMATION SHEET

d. **Door and window detail** (see Figure 12)—Detail drawn to show head, jamb, and sill details of any door or window

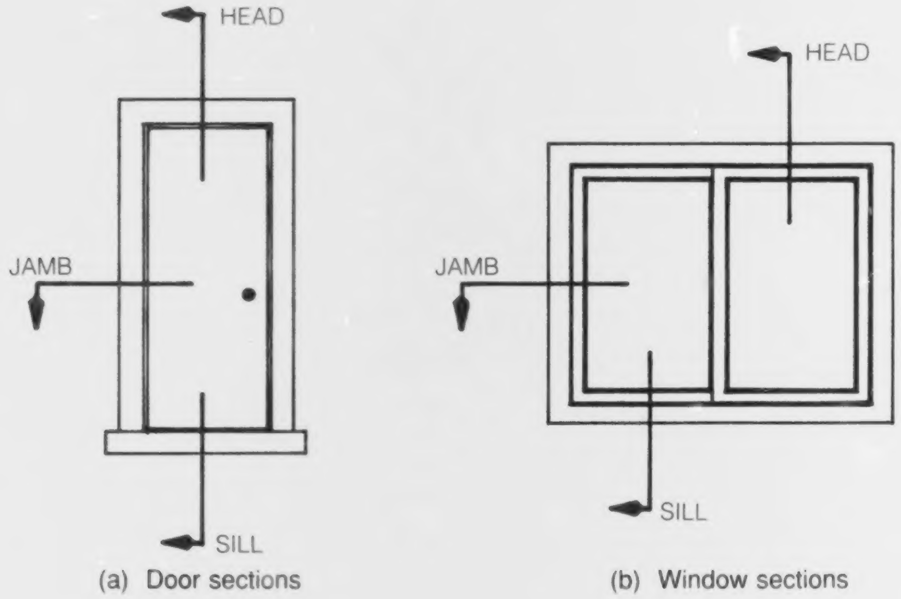
NOTE: For purposes of installing doors and windows, it is normally necessary to show three detailed sectioned areas (head, jamb, and sill) of a door or window. Normally, door and window details are provided in the catalogs of door and window manufacturers.

(1) **Head detail**—Detail drawn to show vertical section through the top of a door or window

(2) **Jamb detail**—Detail drawn to show horizontal section through the side of a door or window

(3) **Sill detail**—Detail drawn to show vertical section through the bottom of a door or window

FIGURE 12



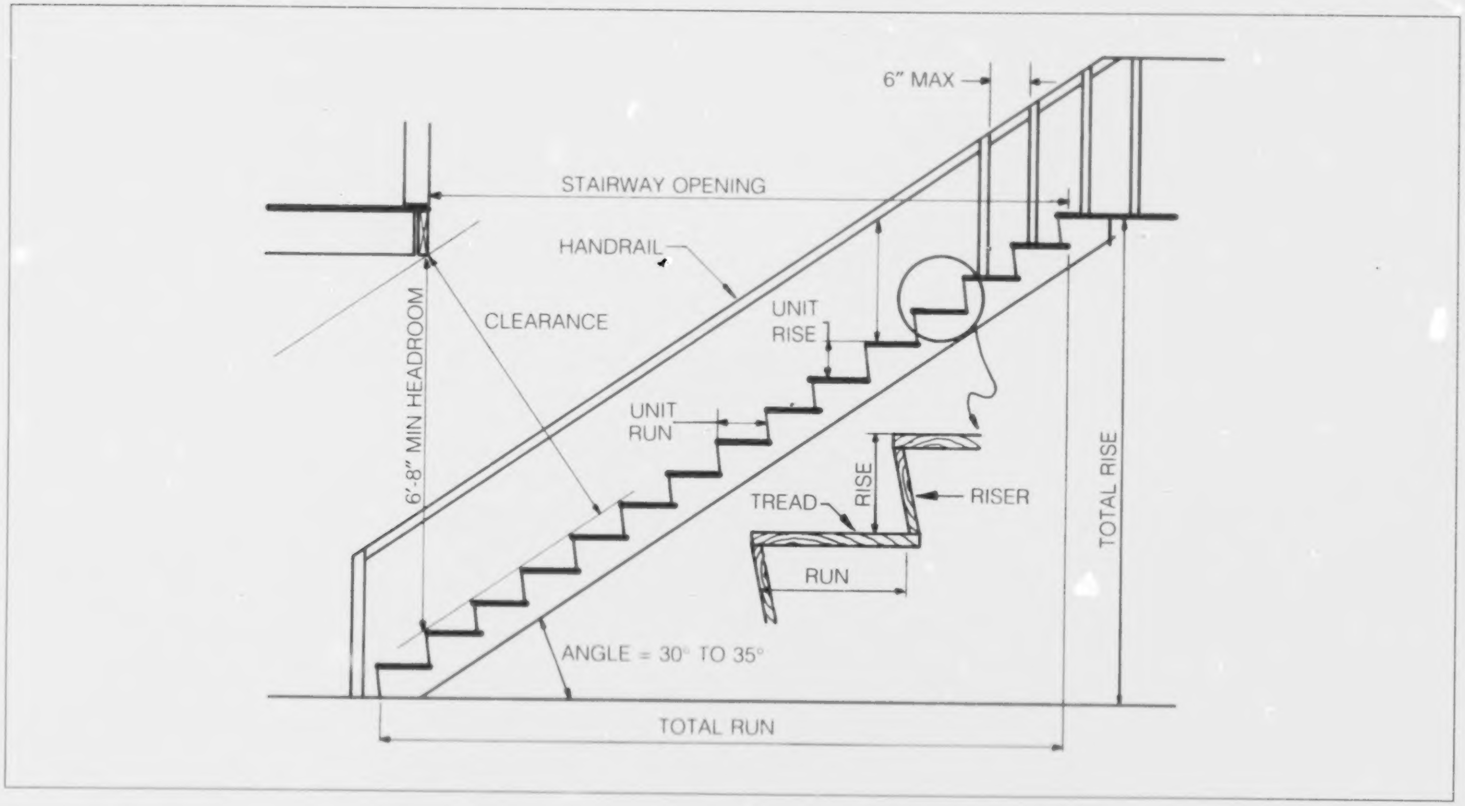
(a) Door sections

(b) Window sections

INFORMATION SHEET

e. **Stairway detail** (Figure 13)—Detail drawn to show dimensional information concerning construction of a stairway

FIGURE 13


6" MAX
STAIRWAY OPENING
HANDRAIL
CLEARANCE
6'-8" MIN HEADROOM
UNIT RISE
UNIT RUN
RISE
TREAD
RISER
RUN
TOTAL RISE
ANGLE = 30° TO 35°
TOTAL RUN

INFORMATION SHEET

7. **Stairway features described on stairway details** (see Figure 13)

NOTE: Listed below are some of the stairway features that must be described on a stairway detail. All dimensional information shown was taken from Sec. 3306 of the *1988 Uniform Building Code*.

a. Total rise (vertical distance of stairs)

b Total run (horizontal distance of stairs)

c. Riser height (minimum, 4 inches; maximum, 7 inches)

d. Tread length (not less than 11 inches)

e. Tread nosing

f. Headroom clearance (minimum, 6′-8″)

g. Handrail height (minimum, 36 inches; maximum, 38 inches)

h. Landing size (minimum, 36 inches)

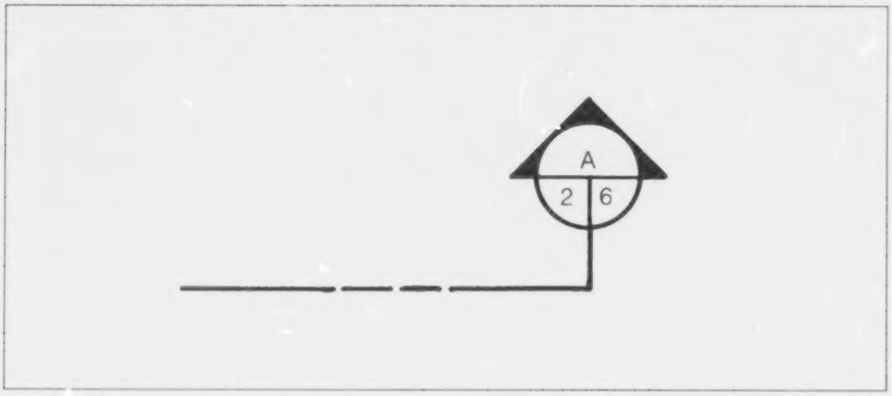
i. All material callouts

8. **Reference methods used for sections and details**

NOTE: As you learned in Unit 4, it is extremely important to be able to reference certain types of drawings and various sheets to one another. Reference methods for sections and details are among the most commonly used and most important to understand.

a. **Section method** (Figure 14)

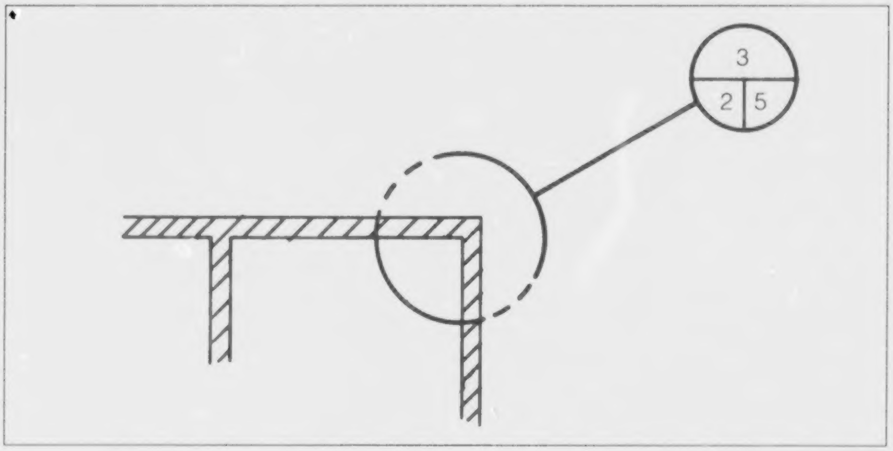
FIGURE 14



INFORMATION SHEET

b. **Detail method** (Figure 15)

FIGURE 15



9. **Descriptions of the components of symbols used in referencing sections and details**

a. **Section-reference method** (Figure 16)

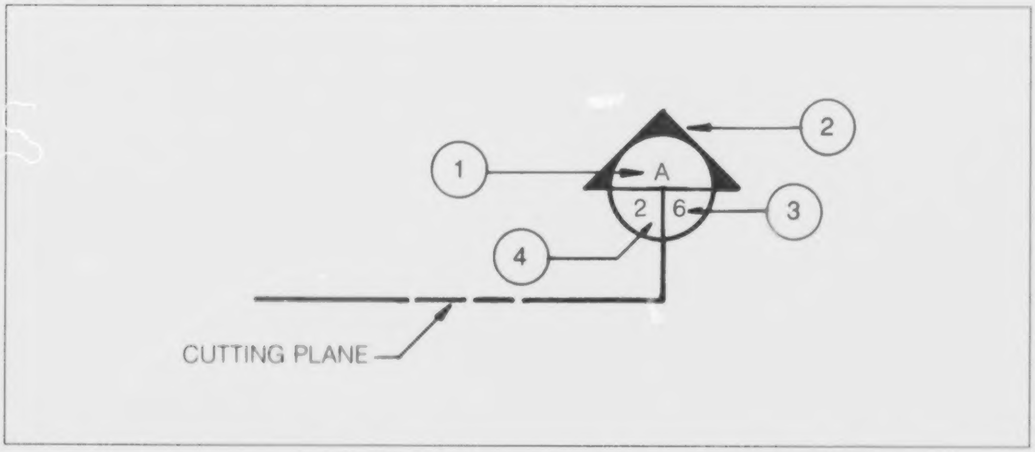
(1) Section identification (ID) letter

(2) Symbol indicating direction of sight

(3) Number indicating sheet number where section view is to be shown

(4) Number indicating sheet number from which section is taken

FIGURE 16



INFORMATION SHEET

b. **Detail-reference method** (Figure 17)

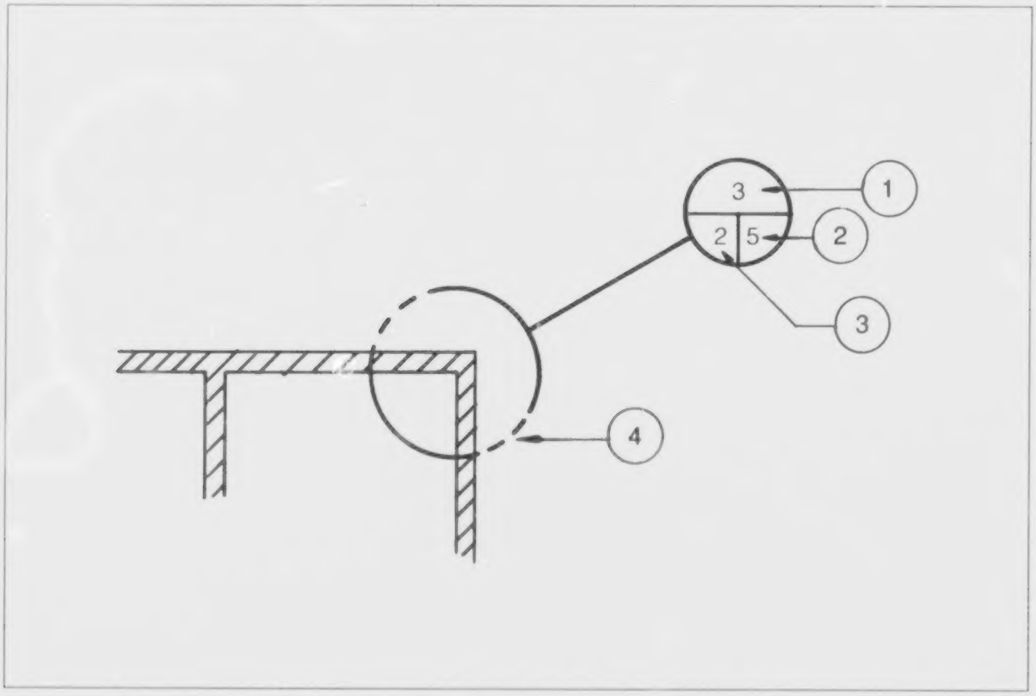
(1) Number indicating detail number

(2) Number indicating sheet number where detail is to be shown

(3) Number indicating sheet number from which detail is taken

(4) Symbol indicating area to be enlarged

FIGURE 17



SECTION AND DETAIL DRAWINGS
UNIT 5

STUDENT SUPPLEMENT 1—DRAWING SCALES USED FOR SECTIONS AND DETAILS

Sections

- Complete-building sections (longitudinal and transverse) should be drawn at the same scale used to produce the corresponding elevation drawings. Using the same scale for these types of drawings allows for a proportional comparison between the elevation (exterior view) and the building section (cut-away interior view).

- Wall sections are drawn at scales that vary from ½″ = 1′-0″ to 1½″ = 1′-0″, depending on how much detail needs to be enlarged to satisfy the drawing's objective.

Details

- A wide range of scales is used to draw details. Scales as small as ½″ = 1′-0″ to as large as 3″ = 1′-0″ or greater are common. The only guideline used in determining a scale for a particular detail drawing is to consider how much enlargement is necessary for the reader to be able to understand the drawing.

SECTION AND DETAIL DRAWINGS
UNIT 5

ASSIGNMENT SHEET 1—DEVELOP A FOOTING DETAIL

Name ______________________________ Score ______________

Introduction

A drafter will often be responsible for developing section and detail drawings from written criteria and/or sketches provided by an architect. In the following assignment, you will practice developing a complete footing detail from the information provided in the exercise below.

Exercise

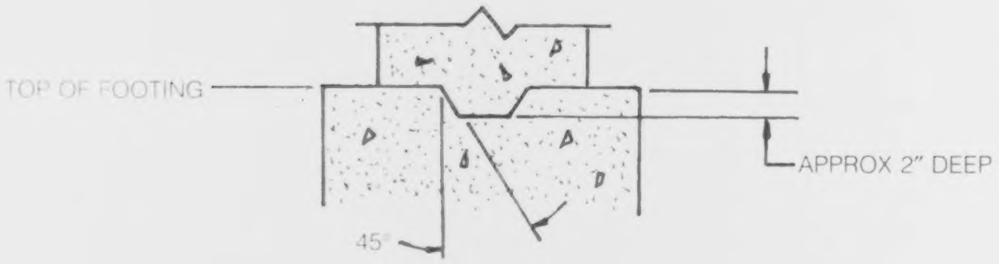
Directions

Study the following footing-detail information and keyway sketch, and then develop a complete footing detail from the information provided. Use correct symbology and dimensions.

Footing-detail information

- Paper size—8½" × 11"
- Scale—½" = 1'-0"
- Footing—24-inch-square, 12-inch-deep poured concrete
- Foundation wall—14-inch-thick poured concrete
- Top of footing—30 inches below grade line
- Footing keyway—Yes (see sketch)

Keyway sketch



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SECTION AND DETAIL DRAWINGS
UNIT 5

ASSIGNMENT SHEET 2—DEVELOP A SILL DETAIL

Name ______________________________ Score ____________

Introduction

A *detail drawing* is a large-scale graphic of part of another drawing, indicating special features of design, location, and composition and the correlation of the elements and materials shown. A *sill detail* shows the design, location, and composition of a horizontal bottom member of a framed unit. In this assignment sheet, you will practice the skills required in drawing a detail by completing a sill detail.

Exercise

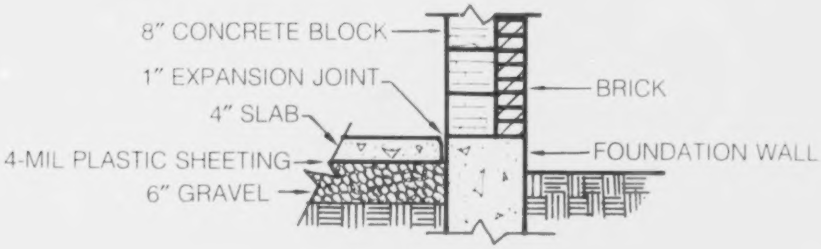
Directions

Review the footing-detail information and keyway sketch presented in Assignment Sheet 1, and study the following sill-detail information and sketch. Then develop a complete sill detail from the information provided. Use correct symbology and dimensions.

Sill-detail information

- Scale—¾″ = 1′-0″
- Paper size—8½″ × 11″
- Exterior wall—4-inch common brick over 8-inch concrete block with 1-inch air space between
- Floor—4-inch concrete slab over 6-inch gravel bed with 4-mil. plastic sheeting laid between; 1-inch expansion joint placed between floor slab and foundation wall

Sketch



SECTION AND DETAIL DRAWINGS
UNIT 5

ASSIGNMENT SHEET 3—DEVELOP A CORNICE DETAIL

Name ______________________________ Score ______________

Introduction

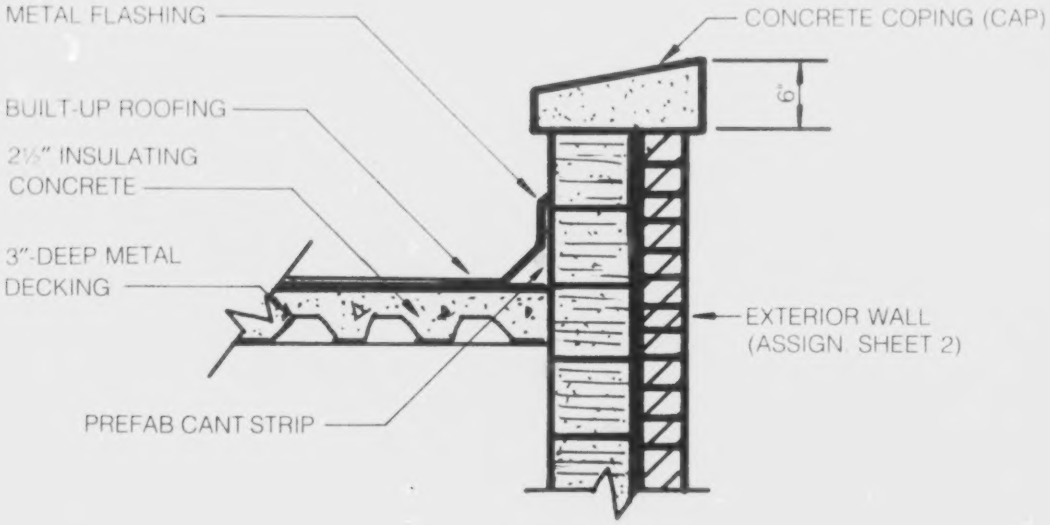
A *cornice detail* shows the design, location, and composition of the framing and trim members of a cornice--the exterior structural trim along the intersection of the roof and the top of a wall. In this assignment sheet, you will continue practicing the skills required in drawing a detail by completing a cornice detail.

Exercise

Directions

Review the information for the exterior wall presented in Assignment Sheet 2, and study the cornice-detail information presented in the sketch below. Then, draw a complete cornice detail to scale using correct symbology and dimensions. Consult Sweets catalogs for exact dimensional information on material callouts.

Cornice-detail sketch


METAL FLASHING
CONCRETE COPING (CAP)
6"
BUILT-UP ROOFING
2½" INSULATING CONCRETE
3"-DEEP METAL DECKING
EXTERIOR WALL (ASSIGN. SHEET 2)
PREFAB CANT STRIP

SECTION AND DETAIL DRAWINGS
UNIT 5

ASSIGNMENT SHEET 4—SELECT NECESSARY SECTION VIEWS FROM A FLOOR PLAN

Name ________________________________ Score ______________

Introduction

A *section view* is a cut-away view through an object or wall to show its interior makeup. As you learned in Objective 4, a drafter must develop section views using cutting-plane lines placed through various portions of a floor plan and accompanying elevation drawings, and that cutting-plane lines are placed only after careful consideration as to what locations will best show all of the different construction-materials methods to be used. In this assignment sheet, you will practice selecting locations for cutting-plane lines from which section views will be developed.

Exercises

Part A

Directions

In Unit 4, Assignment Sheets 3 and 4, you developed a floor plan and an elevation plan for a proposed fire station. Review these plans, and the study the scenario presented below. Then make a print of your floor-plan drawing. On the print, use the architectural method to place cutting-plane lines in the areas you think are appropriate.

Scenario

Congratulations! The floor plan and elevation drawings you developed were accepted by the city planning commission. The commission would like you to continue to develop a full set of working drawings for the proposed fire station. Your next step in developing a complete set of drawings is to determine the necessary building sections and detail drawings.

Part B

Directions

On the blanks provided below and on the next page, explain why you placed cutting-plane lines where you did on the print. Then discuss your explanation with your instructor.

____

____

____

ASSIGNMENT SHEET 4

SECTION AND DETAIL DRAWINGS
UNIT 5

ASSIGNMENT SHEET 5—DEVELOP A LONGITUDINAL SECTION

Name ______________________________ Score ______________

Introduction

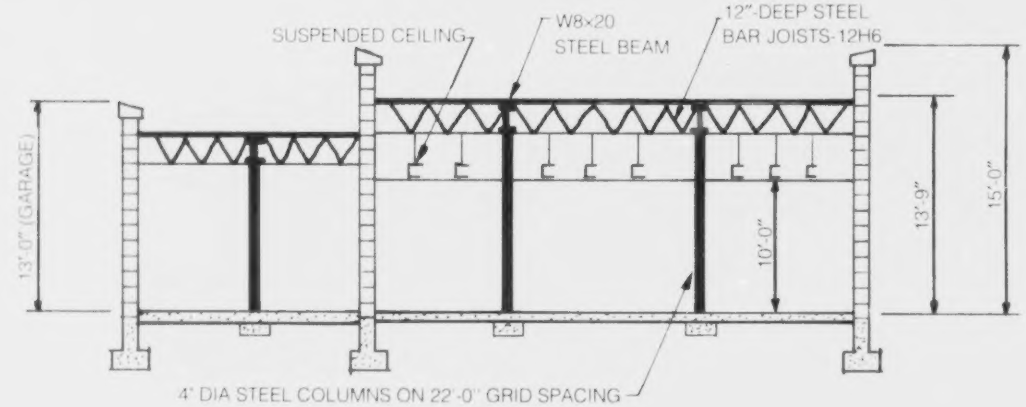
As you learned in Objective 4, a *longitudinal section* is a complete-building section view in which a cutting plane runs through the entire length of a structure. In this assignment sheet, you will continue practicing the skills you need to develop section views by completing a longitudinal section view from the cutting-plane lines you placed on the floor plan in Assignment Sheet 4.

Exercise

Directions

Review the building criteria listed for the proposed fire station in Unit 4, Assignment Sheets 3 and 4. Also review your floor plan of the proposed fire station and the cutting-plane lines you placed on the print of the floor plan in Assignment Sheet 4 of this unit. Then study the sketch below presenting longitudinal-section information. From these sources of information, develop a longitudinal section to the scale you used for your floor-plan drawing. Use correct symbology and dimensions. Refer to *Architectural Graphic Standards* for exact dimensional data.

Longitudinal-section information


SUSPENDED CEILING
W8×20 STEEL BEAM
12"-DEEP STEEL BAR JOISTS-12H6
13'-0" (GARAGE)
10'-0"
13'-9"
15'-0"
4" DIA STEEL COLUMNS ON 22'-0" GRID SPACING

SECTION AND DETAIL DRAWINGS
UNIT 5

ASSIGNMENT SHEET 6—DEVELOP A WALL-SECTION DRAWING

Name ______________________ Score ____________

Introduction A complete wall-section drawing is always required within a set of working drawings to supply specific dimensions, materials, and construction methods to the builder. In this assignment, you will practice developing a complete wall-section drawing.

Exercise

Directions Review all the drawings you have created for the proposed fire station, and then construct a complete wall-section drawing to the selected scale that has been approved by your instructor.

SECTION AND DETAIL DRAWINGS
UNIT 5

WRITTEN TEST

Name ______________________________ Score ______________

1. Match terms associated with section and detail drawings to their correct definitions. Write the numbers on the blanks provided.

______a. Any vertical member on either side of a framed unit

______b. Horizontal surface of a stair, including nosing

______c. Prominent extension of a stairway tread beyond the vertical face of a stair

______d. Exterior structural trim along intersection of roof and top of wall; includes all framing and trim members

______e. Any horizontal bottom member of a framed unit

______f. Any horizontal upper member of a framed unit

______g. Vertical face of a stair from top to bottom

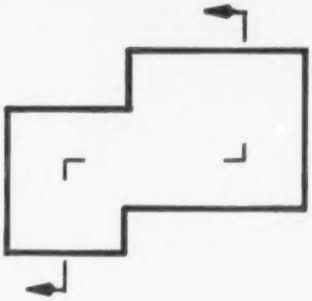
______h. Section of foundation that supports and distributes structural loads directly to the soil

______i. Heavy broken line on a drawing with perpendicular arrows and letters or numbers at each end; used to indicate the plane at which a cross section is taken and the direction of viewing the object

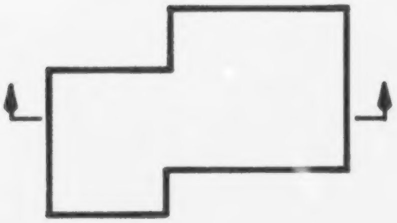
1. Cornice
2. Cutting-plane line
3. Footing
4. Head
5. Jamb
6. Nosing
7. Riser
8. Sill
9. Tread

WRITTEN TEST

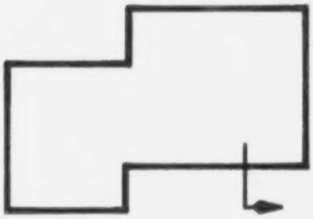
2. Label architectural methods used in drawing cutting-plane lines. Write your answers on the blanks provided under each of the illustrations below.



a. ____



b. ____



c. ____

WRITTEN TEST

3. State definitions of the terms *detail drawing* and *section drawing*. Write your answers on the blanks provided beside each of the terms below.

   a. Detail drawing ____

   ____

   ____

   b. Section drawing ____

   ____

   ____

4. Match types of architectural section drawings to their correct descriptions. Write the numbers on the blanks provided.

   _____a. Section view in which cutting plane runs through a wall from the top of the roof to the bottom of the foundation

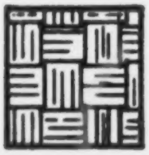
   _____b. Complete-building section view in which cutting plane runs through entire length of structure

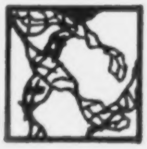
   _____c. Complete-building section view in which cutting plane runs perpendicular to longitudinal cutting plane

   1. Longitudinal section
   2. Transverse section
   3. Wall section

5. Identify the following illustrations of symbols used on section drawings. Write your answers on the blanks provided under each of the illustrations below.

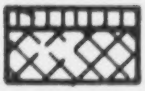
Earth
Marble
Flagstone
Aggregate
Ceramic tile
Rock
Cut slate
Wood
Sand
Concrete
Cinders
Steel

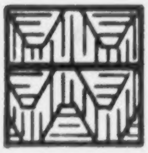




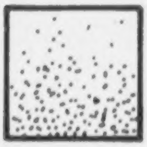
a. ______________________ b. ______________________

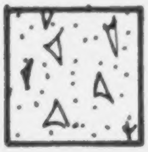
WRITTEN TEST



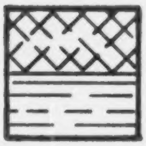


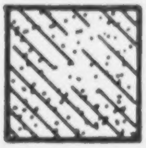
c. ____________________ d. ____________________



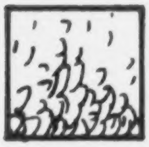


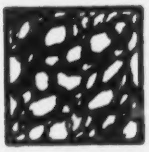
e. ____________________ f. ____________________





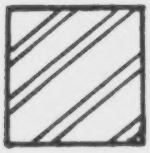
g. ____________________ h. ____________________

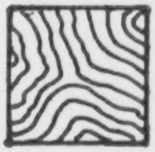




i. ____________________ j. ____________________

WRITTEN TEST





k. ______________________ l. ______________________

6. Match types of architectural detail drawings to their correct descriptions. Write the numbers on the blanks provided.

_____a. Detail drawn to show how exterior wall intersects structure's roofing system and any roof overhang that occurs at that intersection

_____b. Detail drawn to show vertical section through the bottom of a door or window

_____c. Detail drawn to indicate dimensional information and material callouts concerning structure's foundation

_____d. Detail drawn to show head, jamb, and sill details of any door or window

_____e. Detail drawn to show vertical section through the top of a door or window

_____f. Detail drawn to show horizontal section through the side of a door or window

_____g. Detail drawn to show how structure's foundation wall connects to exterior outside wall and floor system

_____h. Detail drawn to show dimensional information concerning construction of a stairway

1. Footing detail
2. Sill detail
3. Cornice detail
4. Door and window detail
5. Head detail
6. Jamb detail
7. Sill detail
8. Stairway detail

7. List 6 of the 9 stairway features described on stairway details. Write your answers on the blanks provided.

a. ____

b. ____

c. ____

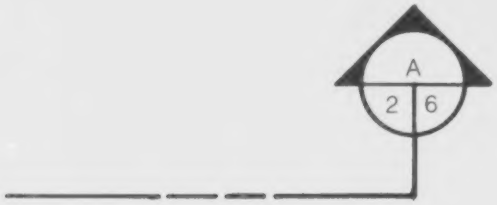
d. ____

e. ____

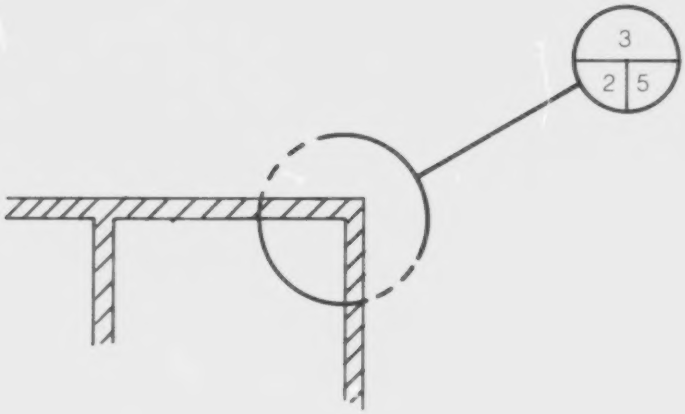
f. ____

WRITTEN TEST

8. Label reference methods used for sections and details. Write your answers on the blanks provided under each of the illustrations below.



a. ______________________________



b. ______________________________

WRITTEN TEST

9. Interpret symbols used in referencing sections and details. Write your answers on the blanks provided under each of the illustrations below.

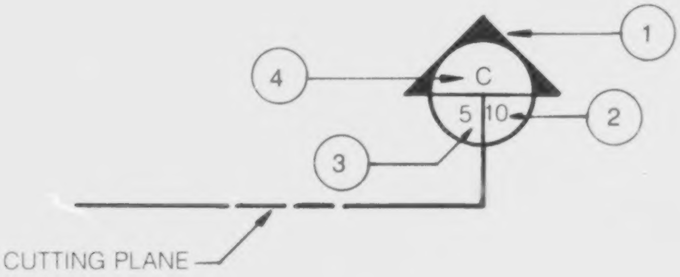

1
4
C
5
10
2
3
CUTTING PLANE

Illustration a

(1) ______

(2) ______

(3) ______

(4) ______

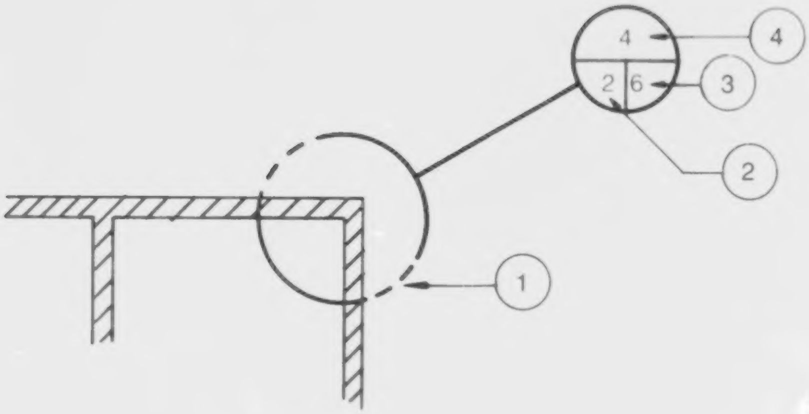


Illustration b

(1) ______

(2) ______

(3) ______

(4) ______

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STRUCTURAL SYSTEMS
UNIT 6

UNIT OBJECTIVE

After completing this unit, the student should be able to state definitions of the major components of a structural system, identify basic components of structural systems, and describe the forces exerted on a structural system. The student should also be able to develop a complete foundation plan, foundation sections, and a roof framing plan. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with structural systems to their correct definitions.
2. Define the term *structural system.*
3. List types of materials used in structural systems.
4. State descriptions of the types of forces exerted on a structural system.
5. State definitions of the major components of a structural system.
6. Distinguish between the purposes of the basic components of a substructure.
7. Label types of footings.
8. List types of information shown on a foundation plan.
9. Match basic types of superstructures to their correct descriptions.
10. List factors considered in commercial roof design.
11. Identify types of roofs.
12. List types of materials used as roof framing members.
13. Match types of materials used as roof coverings to their correct descriptions.
14. Distinguish among the descriptions of other components to be considered in commercial roof design.
15. List the types of information shown on a roof framing plan.
16. Analyze the effects of structural forces on building design. (Assignment Sheet 1)
17. Develop a foundation plan. (Assignment Sheet 2)
18. Develop required foundation sections. (Assignment Sheet 3)
19. Develop a roof framing plan. (Assignment Sheet 4)

STRUCTURAL SYSTEMS
UNIT 6

SUGGESTED ACTIVITIES

Preparation

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery and Application" section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.
- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section.
- Make transparencies from the transparency masters included in this unit.
- Duplicate teacher supplement included in this unit, as required.
- Prepare classroom and lab. Put up posters, charts, and signs; display articles and other references related to the objectives of this unit.

Delivery and Application

Unit introduction

- Provide students with objective sheet. Discuss unit and specific objectives.
- Show the films *World of Construction: Identifying Superstructures* and *World of Construction: Enclosing Nonresidential Structures*. Hold a class discussion explaining the concepts of structural systems and how they vary from commercial to industrial to residential applications.
- Take students on a field trip to an area of the city that contains primarily commercial buildings. Have students identify the different structural systems (steel framing, wood framing, masonry) that have been used in the various buildings. Point out to students that particular structural systems are common with certain types of buildings (multistory buildings are commonly steel frame with glass or veneer).
- Provide students with information sheet. Discuss information sheet.

SUGGESTED ACTIVITIES

Objective 1 Match terms associated with structural systems to their correct definitions.

- Show examples that illustrate terms and make examples available in the classroom.

Objective 2 Define the term *structural system*.

Objective 3 List types of materials used in structural systems.

- Discuss the definition of the term *structural system* and then discuss the basic types of framing methods as well as the common building materials used in structural systems. Discuss the advantages and disadvantages of each of the materials discussed in Objective 3. Read to students the note following the item on steel framing members. Stress the fact that steel framing members have become the most popular materials in commercial construction. Hand out copies of Teacher Supplement 1, "Steel Framing Members," to illustrate your discussion.
- List criteria for a proposed project (building size, number of floors, use of structure) on the chalkboard. Have students select a structural framing method to be used for the proposed project and then support their answer by explaining why that particular method was selected.

Objective 4 State descriptions of the types of forces exerted on a structural system.

- Discuss with students the items presented in the objective and the impact these forces have on determining the building materials used in constructing a building. Use Transparency 1, "Forces Exerted on a Structural System," and Transparency 2, "Expansion Joint," and the artwork presented in the objective to illustrate your discussion.
- Identify physical items in the classroom and in the building that contains the classroom. Have students define the structural force associated with the items identified.
- Hand out Assignment Sheet 1, "Analyze the Effects of Structural Forces on Building Design." Read to students the introduction and the directions to the assignment. Answer any student questions, and then have students complete Assignment Sheet 1.

Objective 5 State definitions of the major components of a structural system.

- Read to students the information presented in the objective, explaining the differences between a substructure and a superstructure.

SUGGESTED ACTIVITIES

- Explain to students that the basic components of a substructure and superstructure and the drawings done in association with these components will be explored in the remainder of the information sheet.

Objective 6 Distinguish between the purposes of the basic components of a substructure.

Objective 7 Label types of footings.

Objective 8 List types of information shown on a foundation plan.

- Read to students the introduction to Objective 6 and the definitions of a footing and a foundation wall. Explain the importance of a properly designed footing and foundation wall.
- Discuss with students each type of footing illustrated in Objective 7. Use Transparencies 3 through 6 to illustrate your discussion. Ask students what type of footings would be most common in your part of the city or state, in your part of the country, and in other parts of the country. Explain why different footings are used in these various locations.
- Discuss with students types of foundation walls and the various building materials used to construct these types of walls. Use Transparency 7, "Types of Foundation Walls," to illustrate your discussion.
- Read to students the note introducing Objective 8 and then refer to the listing of information shown on a foundation plan. Draw a simple plan on the chalkboard and then draw in each item (material-symbol hatching, floor-surface callouts, etc.) when each is discussed.
- Discuss the illustration of a foundation plan shown in Figure 15 of the information sheet and Transparency 8. Explain each of the callouts indicated on the illustration.

Objective 9 Match basic types of superstructures to their correct descriptions.

- Discuss the three basic types of superstructures presented in the objective. Then, have students give examples of each type, naming specific structures they know of in their city and/or state.

Objective 10 List factors considered in commercial roof design.

Objective 11 Identify types of roofs.

SUGGESTED ACTIVITIES

Objective 12 List types of materials used as roof framing members.

Objective 13 Match types of materials used as roof coverings to their correct descriptions.

Objective 14 Distinguish among the descriptions of other components to be considered in commercial roof design.

- Use Objectives 10 through 14 to discuss components of a superstructure.
- Illustrate common roof types by showing an example of each one on the board. Explain their relative advantages and disadvantages (cost, construction, appearance).
- Use Transparency 9, "Roof Framing Members," to discuss common commercial roof-framing materials and methods.
- Discuss each of the roof-covering materials shown in Objective 12. Explain common applications as well as advantages and disadvantages for each.
- Explain to students construction and design considerations that must be accounted for when determining a roof type (drainage and overhang). Illustrate on the board the uses of roof overhangs (provide shade), parapet walls (improve building appearance and help control water drainage), and possible water-drainage systems.

Objective 15 List the types of information shown on a roof framing plan.

- Read to students the note introducing the objective. Stress the function of a roof framing plan. Then use Transparency 10, "Roof Framing Plan," to identify the items listed in the objective.

Assignment Sheets 2 through 4

- Explain to students that in Assignment Sheets 2 through 4 they will continue developing a set of working drawings for a fire station. In these assignments, they will complete a foundation plan, required foundation sections, and a roofing plan for the structure.
- Read the introduction to Assignment Sheet 2, "Develop a Foundation Plan." Discuss each item given in the criteria and the information presented in the sketch shown. Have students complete Assignment Sheet 2.

SUGGESTED ACTIVITIES

- Read the introduction to Assignment Sheet 3, "Develop Required Foundation Sections." Discuss with students the directions to Parts A, B, and C of the exercises. Answer student questions and then have students complete Assignment Sheet 3.
- Read the introduction to Assignment Sheet 4, "Develop a Roof Framing Plan." Discuss the drawings students will need to refer to in order to construct the roof framing plan for the fire station. Also discuss the supplemental information provided in the assignment. Answer all student questions and then have students complete Assignment Sheet 4.

Evaluation

- Give written test.
- Compile written-test and assignment-sheet scores on Unit Evaluation Form.
- Reteach and retest as required.

Suggested Resources

Resources used in developing unit

Print media

- Callendar, John. *Time Saver Standards for Architectural Design Data*, 6th ed. New York: McGraw-Hill, 1982.
- Helper, D.E., and Paul Wallach. *Architecture, Drafting, and Design*. New York: McGraw-Hill, 1987.
- Muller, Edward. *Architectural Drawing and Light Construction*. Englewood Cliffs, New Jersey: Prentice-Hall, 1985.
- Spence, William P. *Architecture: Design, Engineering, Drawing*. Bloomington, Illinois: Glencoe, Bennett, and McKnight, 1985.

Additional resources

Media

- *World of Construction: Identifying Superstructures*. Copyright 1989, available on filmstrip and VHS cassette. Opportunities for Learning, 20417 Nordhoff Street, Dept. 1N, Chatsworth, California 91311.

  This program discusses the basic types of superstructures constructed for various applications (commercial, residential, and industrial) in today's world.

SUGGESTED ACTIVITIES

- *World of Construction: Enclosing Nonresidential Structures*. Copyright 1989, available on filmstrip and VHS cassette. Opportunities for Learning, 20317 Nordhoff Street, Dept. 1N, Chatsworth, California 91311.

  This program takes a look at commercial building techniques as they apply to structural framing and exterior building materials.

Print media

- *Manual of Steel Construction*, 8th ed. Chicago: American Institute of Steel Construction, 1980.
- Ramsey, Charles. *Architectural Graphic Standards*, 8th ed. New York: Wiley and Sons, 1988.
- *Uniform Building Code*. Walnut, California: International Conference of Building Officials, 1988.

STRUCTURAL SYSTEMS
UNIT 6

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

1. a. Snow
   b. Ice
   c. Equipment
   d. People

2. c. Lateral load

3. Pounds per square foot

4. Construction materials

5. Expansion joint

Assignment Sheet 2 Evaluated to the satisfaction of the instructor.

Assignment Sheet 3 Evaluated to the satisfaction of the instructor.

Assignment Sheet 4 Evaluated to the satisfaction of the instructor.

STRUCTURAL SYSTEMS
UNIT 6

ANSWERS TO WRITTEN TEST

1. a. 3
   b. 5
   c. 7
   d. 1
   e. 6
   f. 4
   g. 2
   h. 8

2. Weight-bearing frame of a structure

3. Answer should include any 4 of the following

   a. Steel framing members
   b. Solid-masonry members
   c. Concrete-block members
   d. Tilt-up concrete panels
   e. Concrete tees
   f. Interior columns

4. a. All movable bodies within a structure
   b. All permanent or unmovable parts of a structure
   c. External horizontal forces
   d. Naturally occurring forces caused by the expansion and contraction of the various building materials used in a structure

5. a. Foundation that supports upper portion of a structure by transmitting loads down to soil
   b. Any portion of a structure that rests upon the foundation

6. a. FW
   b. F

7. a. Slab
   b. Spread
   c. Column
   d. Pile

8. Answer should include any 5 of the following

   a. Material-symbol hatching
   b. Floor-surface callout
   c. Indication of unexcavated areas
   d. Height, width, and depth of support-column footings
   e. Access areas or vents

ANSWERS TO WRITTEN TEST

f. Indication of perimeter footings
g. All necessary dimensions

9. a. 2
b. 3
c. 1

10. Answer should include any 3 of the following

a. Type of roof to be constructed
b. Type of framing material to be used
c. Type of roof covering to be used
d. Other roof components to be included

11. a. Folded-plate d. Gable
b. Hip e. Flat
c. Shed

12. a. Steel products
b. Precast-concrete products
c. Combination steel and concrete products

13. a. 2 d. 3
b. 5 e. 1
c. 4

14. a. P
b. D
c. O

15. a. Type of structural member
b. Size of structural member
c. Center-to-center spacing of members
d. Overhang dimensions
e. Overall dimensions
f. Exterior walls shown for reference

STRUCTURAL SYSTEMS
UNIT 6

UNIT EVALUATION FORM

Student name ______________________________ Unit rating __________

Assignment sheet ratings

Assignment Sheet 1—Analyze the Effects of Structural Forces on Building Design Rating __________

Comments: ______________________________

Assignment Sheet 2—Develop a Foundation Plan Rating __________

Comments: ______________________________

Assignment Sheet 3—Develop Required Foundation Sections Rating __________

Comments: ______________________________

Assignment Sheet 4—Develop a Roof Framing Plan Rating __________

Comments: ______________________________

Written test scores

Pretest __________ Other __________

Posttest __________

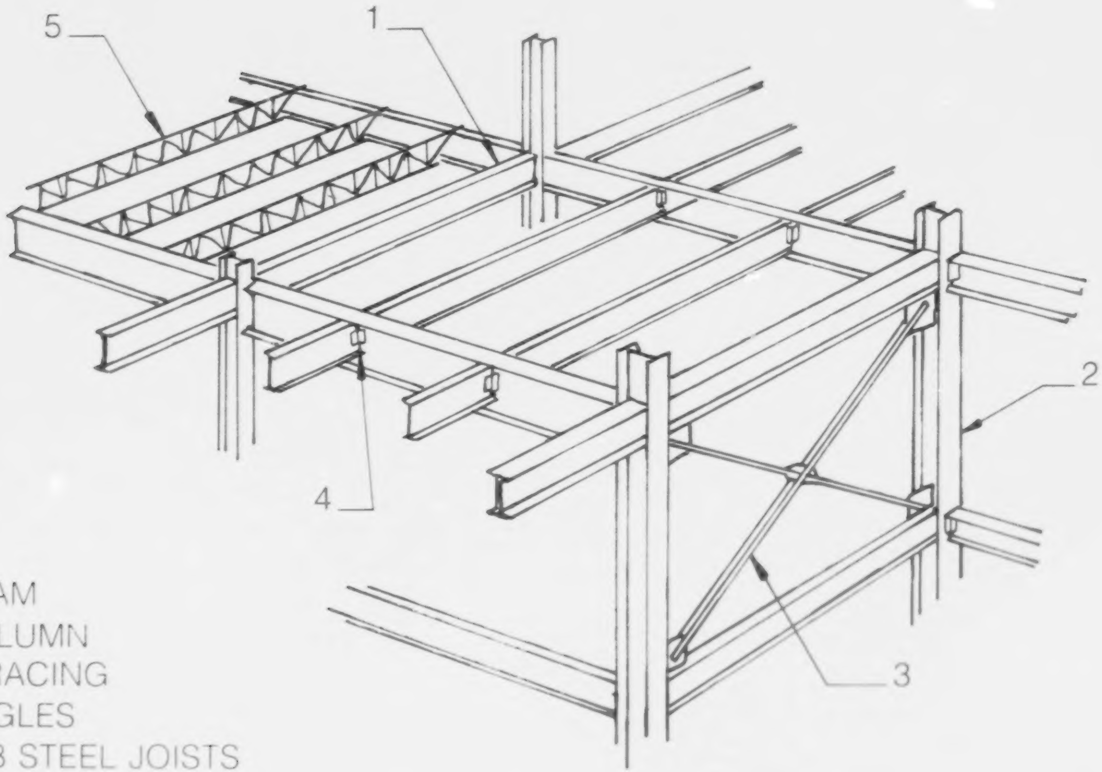
Instructor signature ______________________________ Date __________

Student signature ______________________________ Date __________

Duplication of this form is permitted.

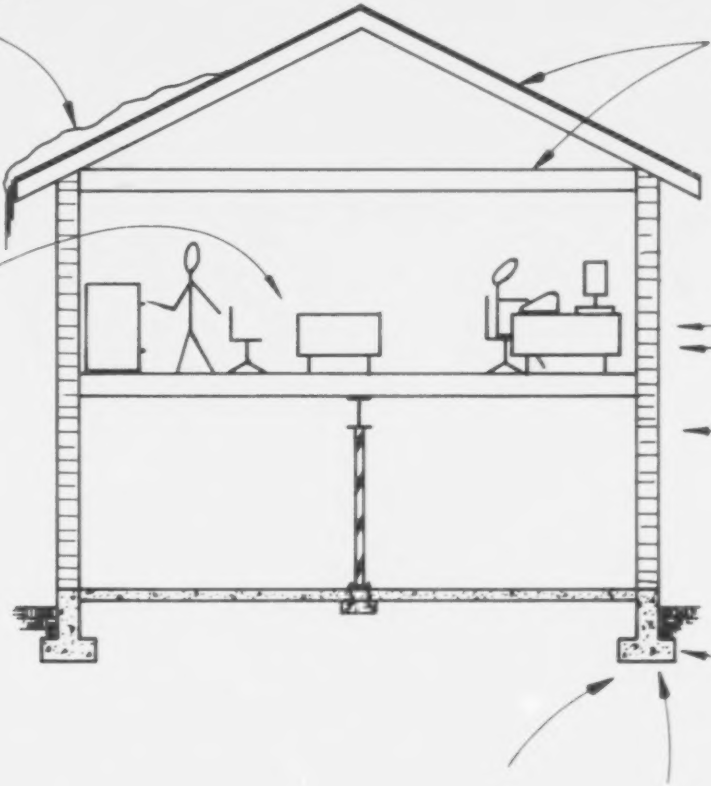
STRUCTURAL SYSTEMS
UNIT 6

TEACHER SUPPLEMENT 1—STEEL FRAMING MEMBERS

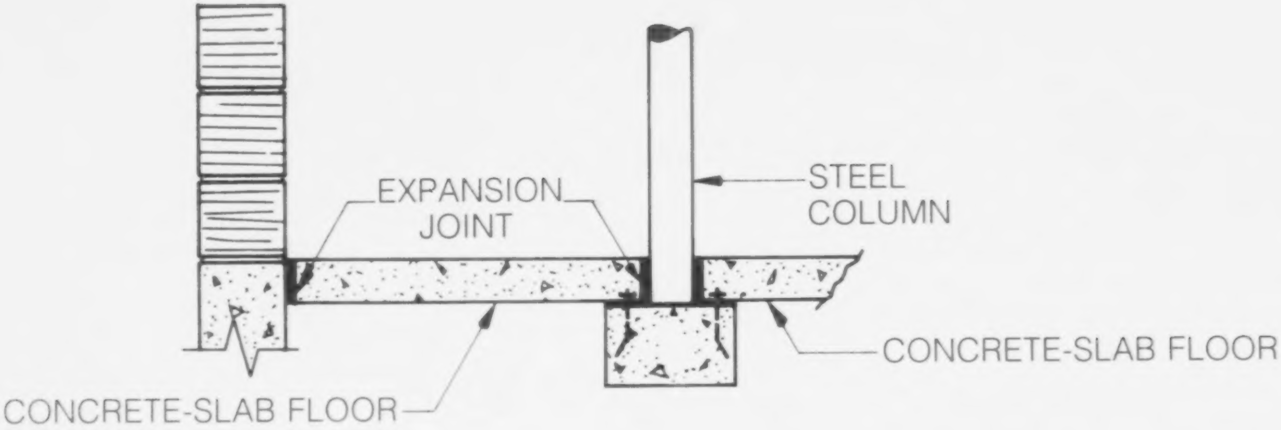


(1) STEEL BEAM
(2) STEEL COLUMN
(3) CROSS-BRACING
(4) STEEL ANGLES
(5) OPEN-WEB STEEL JOISTS

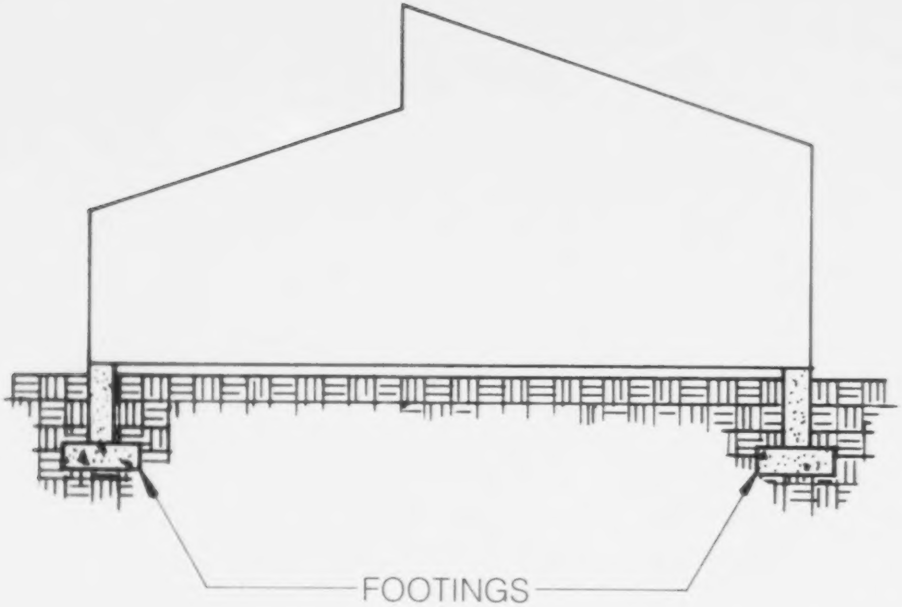
Forces Exerted on a Structural System


SNOW AND ICE
(LIVE LOAD)
BUILDING MATERIALS
(DEAD LOAD)
FURNITURE
AND PEOPLE
(LIVE LOAD)
WINDS
(LATERAL LOAD)
EARTH MOVEMENT
(LATERAL LOAD)

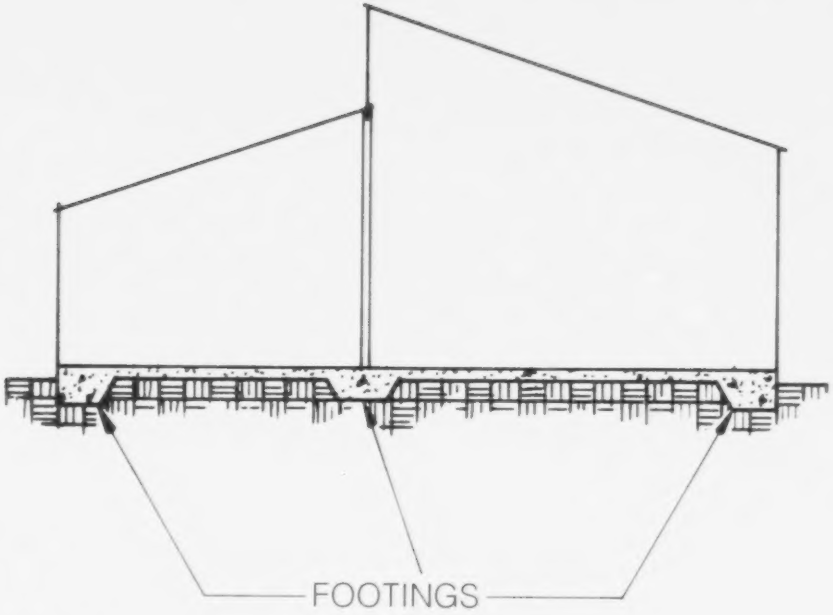
Expansion Joint


EXPANSION JOINT
STEEL COLUMN
CONCRETE-SLAB FLOOR
CONCRETE-SLAB FLOOR

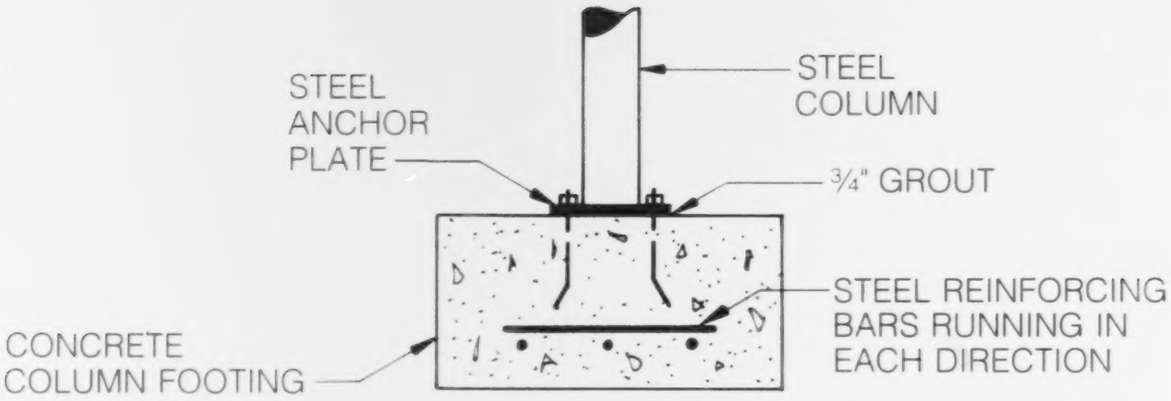
Spread Footing



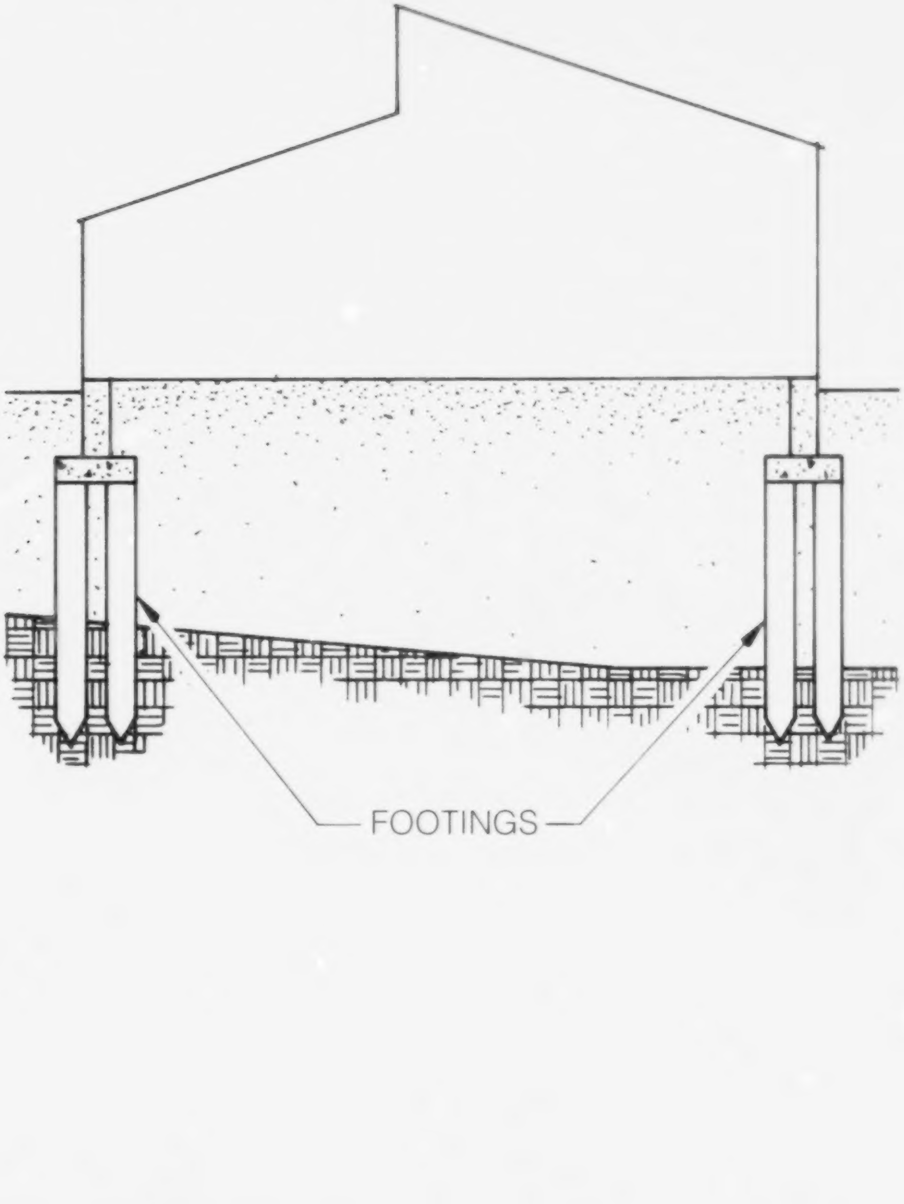
Slab Footing



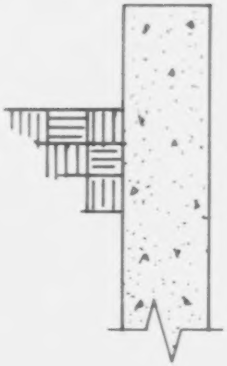
Column Footing


STEEL ANCHOR PLATE
STEEL COLUMN
¾" GROUT
STEEL REINFORCING BARS RUNNING IN EACH DIRECTION
CONCRETE COLUMN FOOTING

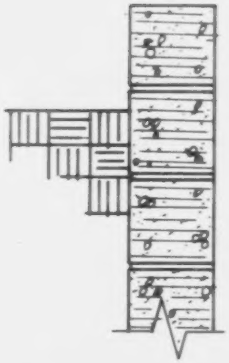
Pile Footing



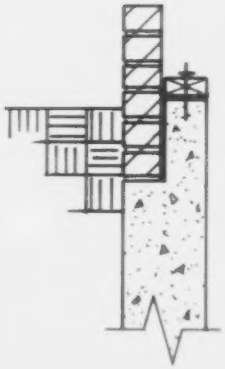
Types of Foundation Walls



Cast-in-place concrete

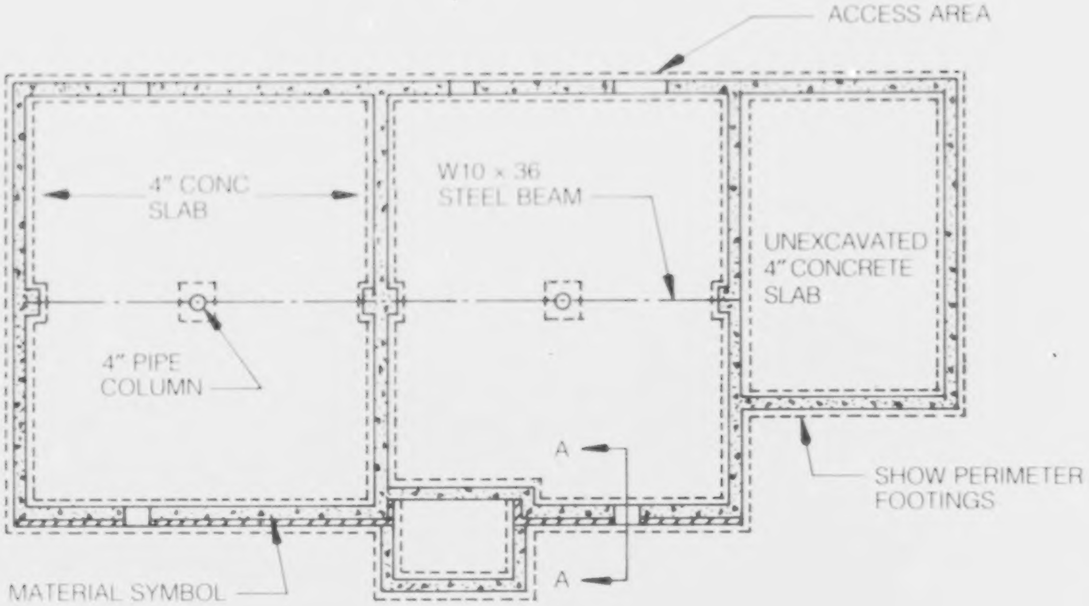


Masonry

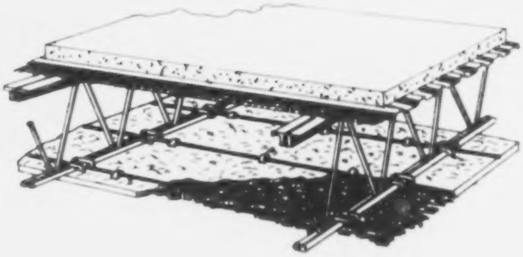


Combined

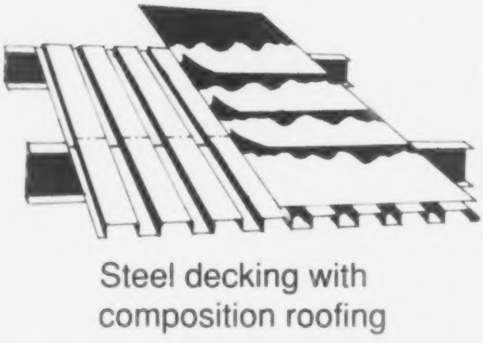
Foundation Plan


ACCESS AREA
4" CONC SLAB
W10 × 36 STEEL BEAM
UNEXCAVATED 4" CONCRETE SLAB
4" PIPE COLUMN
A
A
SHOW PERIMETER FOOTINGS
MATERIAL SYMBOL

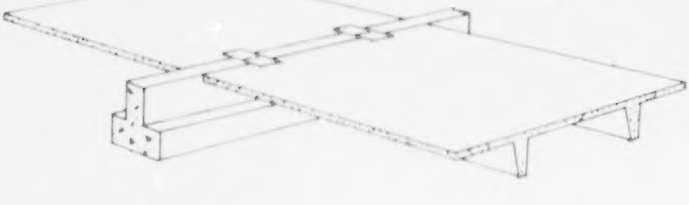
Roof Framing Members



Open-web steel joists
with concrete decking

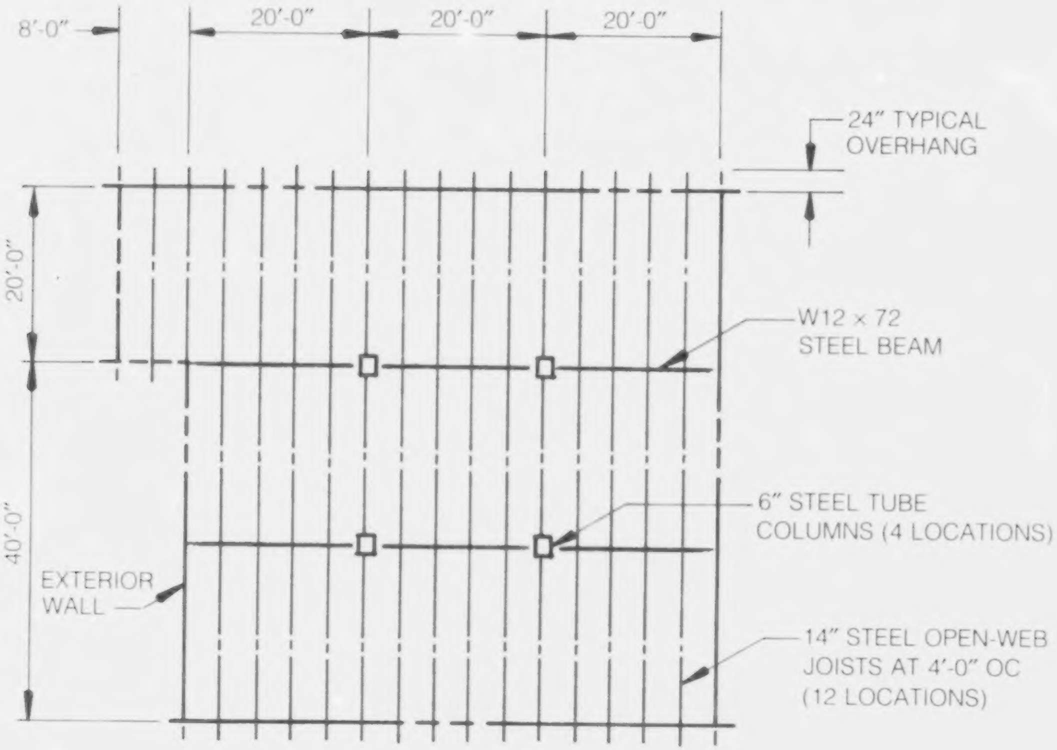


Steel decking with
composition roofing



Concrete double tees
used as part of roof construction

Roof Framing Plan


8'-0"
20'-0"
20'-0"
20'-0"
24" TYPICAL OVERHANG
20'-0"
W12 × 72 STEEL BEAM
40'-0"
6" STEEL TUBE COLUMNS (4 LOCATIONS)
EXTERIOR WALL
14" STEEL OPEN-WEB JOISTS AT 4'-0" OC (12 LOCATIONS)

STRUCTURAL SYSTEMS
UNIT 6

INFORMATION SHEET

1. **Terms and definitions associated with structural systems**

    a. **Column**—Load-bearing vertical structural member with a height at least three times its largest diameter

    b. **Decking**—Light-gage metal sheets used to construct a floor or deck form, or used as floor or deck members; wood members used as finish surface of a deck

    c. **Expansion joint**—Separation between adjoining sections of a concrete slab to allow movement caused by expansion and contraction

    d. **Monolithic slab**—Structural member consisting of a large, single piece of concrete

    e. **Precast concrete**—Large sections of walls, floors, beams, or other structures formed and poured in other than their final position

    f. **Prestressed concrete**—Building method in which stretched steel cables are put in tension and then concrete is placed over cables to form a concrete slab or other concrete structure

    g. **Purlin**—Horizontal support that spans across adjacent beams

    h. **Veneer**—Non-load-bearing exterior surface

2. **Definition of the term *structural system***—Weight-bearing frame of a structure

3. **Types of materials used in structural systems**

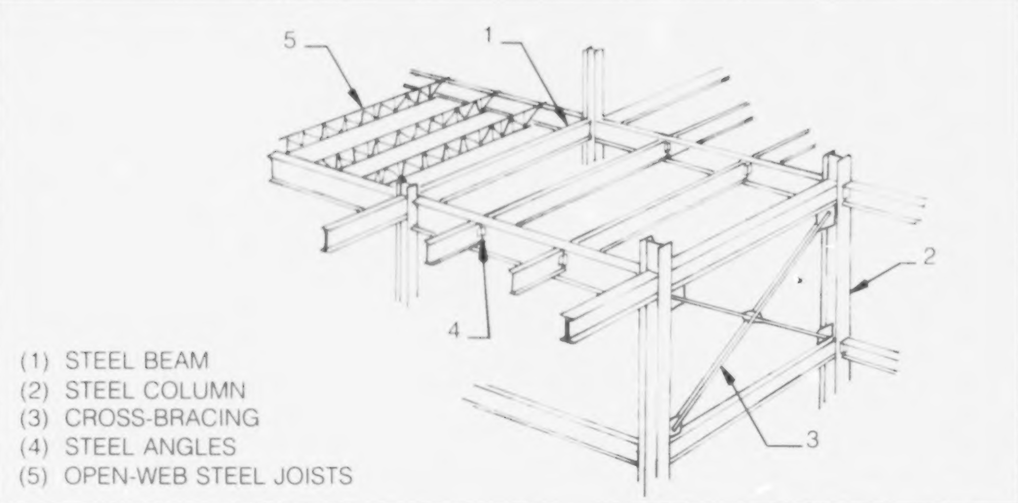
    NOTE: Although the materials (concrete, masonry, steel, wood) used in structural systems have been available for years, recent technological advancements in materials (prestressed concrete, steel alloys) have permitted a wide range of design options allowing architects to achieve functional, aesthetically pleasing structures of improved structural integrity.

    a. **Steel framing members** (see Figure 1)

        NOTE: Using cost-efficient steel framing members such as beams, columns, and joists, architects can design a support skeleton to support a large weight load while spanning long distances, thus allowing multiple-floor structures with large open areas. For these reasons, steel framing members have become the most popular materials used in structural systems for commercial construction.

INFORMATION SHEET

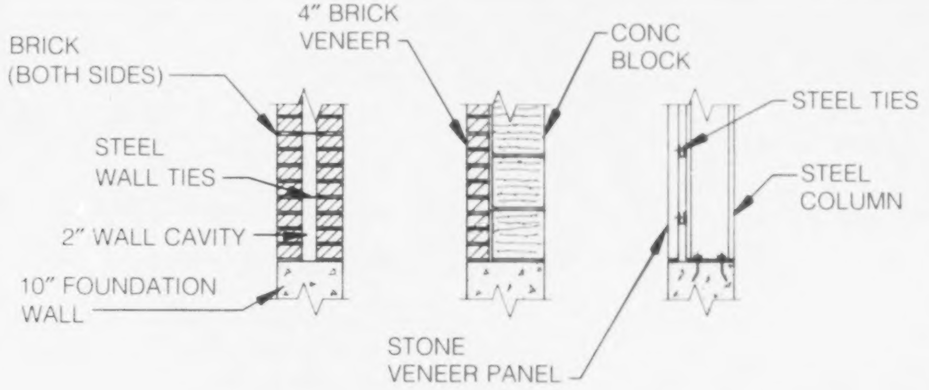
FIGURE 1


5
1
2
4
3
(1) STEEL BEAM
(2) STEEL COLUMN
(3) CROSS-BRACING
(4) STEEL ANGLES
(5) OPEN-WEB STEEL JOISTS

b. **Solid-masonry members**

NOTE: Solid-masonry construction (brick and stone) has been used for centuries because of its beauty and durability. However, common practice today is to use these materials as exterior veneers with load-bearing materials (wood, concrete block, reinforced concrete, steel) behind them. See Figure 2.

FIGURE 2


BRICK (BOTH SIDES)
STEEL WALL TIES
2" WALL CAVITY
10" FOUNDATION WALL
4" BRICK VENEER
CONC BLOCK
STONE VENEER PANEL
STEEL TIES
STEEL COLUMN

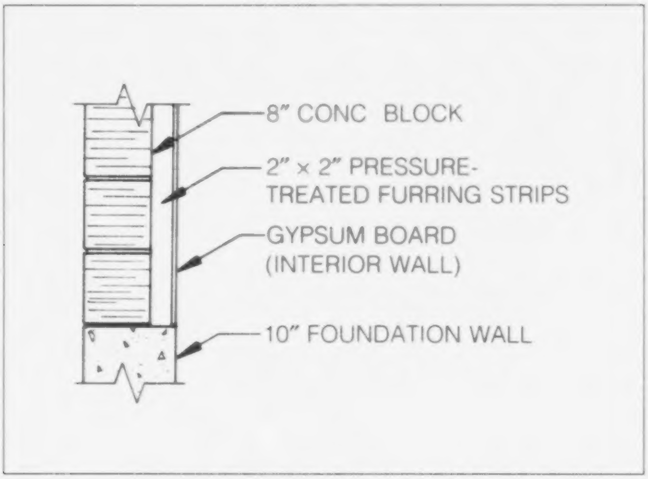
(a) Brick cavity wall (b) Brick veneer (c) Stone veneer

INFORMATION SHEET

c. **Concrete-block members** (Figure 3)

NOTE: Concrete-block construction strengthened with horizontal steel reinforcing bars laid between every second or third course of block has become the most popular framing system for smaller commercial buildings because it combines load-bearing capabilities, insulating value, and a wide selection of surface-finish appearances.

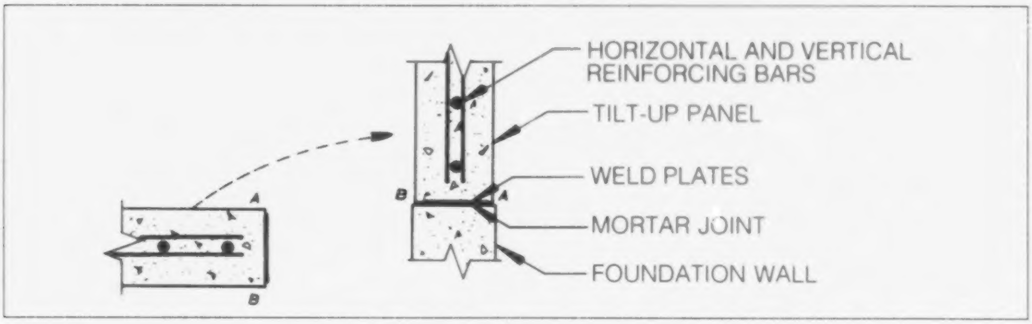
FIGURE 3


8" CONC BLOCK
2" × 2" PRESSURE-TREATED FURRING STRIPS
GYPSUM BOARD (INTERIOR WALL)
10" FOUNDATION WALL

d. **Tilt-up concrete panels** (Figure 4)

NOTE: In tilt-up construction, poured-concrete panels are cast in horizontal wooden forms with steel reinforcement bars extending from the panels. When the concrete has set, the panels are "tilted up" (usually with a crane) and joined to the structure's foundation wall with mortar. Then vertical columns are cast between the tilt-up panels to adhere to the reinforcement bars extending from the panels. A series of these tilted-up concrete panels form a relatively quickly constructed load-bearing exterior wall.

FIGURE 4


HORIZONTAL AND VERTICAL REINFORCING BARS
TILT-UP PANEL
WELD PLATES
MORTAR JOINT
FOUNDATION WALL
A
B
A
B

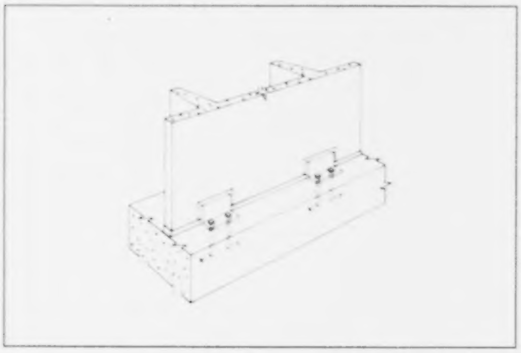
BEST COPY AVAILABLE

INFORMATION SHEET

e. **Concrete tees** (Figure 5)

NOTE: Concrete tees are prefabricated lengths of poured concrete shaped in a single- or double-T formation. Commonly used in commercial construction for load-bearing walls or in roof systems, concrete tees support large weight loads and are easily fastened to foundation walls with steel brackets and anchor bolts.

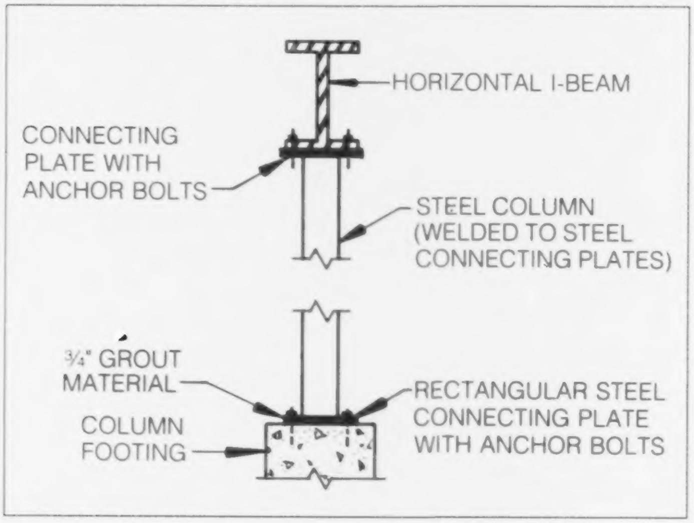
FIGURE 5: Bearing wall constructed with double concrete tees



f. **Interior columns** (Figure 6)

NOTE: Interior columns are used to support horizontal beams that cannot carry building loads from exterior wall to exterior wall. Made primarily of round, rectangular, or I-beam steel shapes that connect to horizontal beams and column footings, interior columns distribute concentrated loads to footings located below the ground.

FIGURE 6


HORIZONTAL I-BEAM
CONNECTING PLATE WITH ANCHOR BOLTS
STEEL COLUMN (WELDED TO STEEL CONNECTING PLATES)
¾" GROUT MATERIAL
COLUMN FOOTING
RECTANGULAR STEEL CONNECTING PLATE WITH ANCHOR BOLTS

INFORMATION SHEET

4. Types of forces exerted on a structural system and their descriptions

NOTE: All structural systems are designed to support weight-bearing loads placed on the structure. Listed below are four fundamental types of forces that must be taken into consideration in the design of any structure. These forces are measured in pounds per square foot (PSF).

a. **Live loads** (see Figure 7)—All movable bodies within a structure

EXAMPLES: People, furniture, vehicles

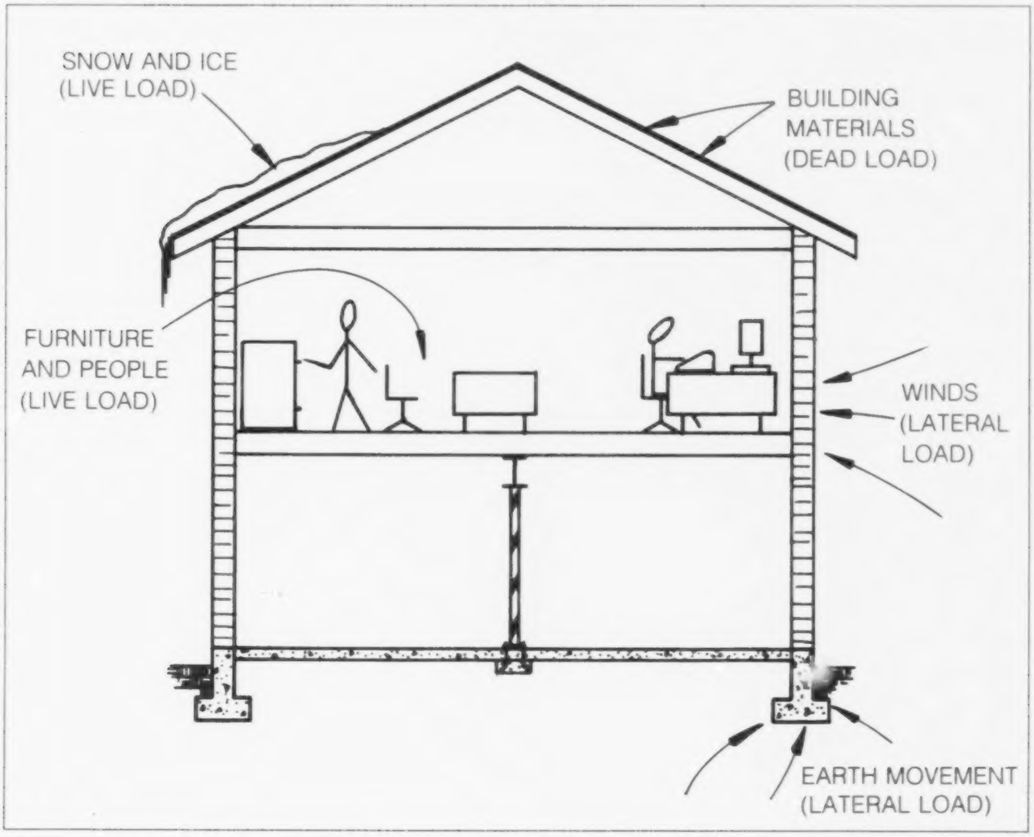
b. **Dead loads** (see Figure 7)—All permanent or unmovable parts of a structure

NOTE: Dead loads consist primarily of the weight of all the construction materials used in the building of a structure.

c. **Lateral loads** (Figure 7)—External horizontal forces

EXAMPLES: Wind, earth movement such as soil expansion and contraction

FIGURE 7

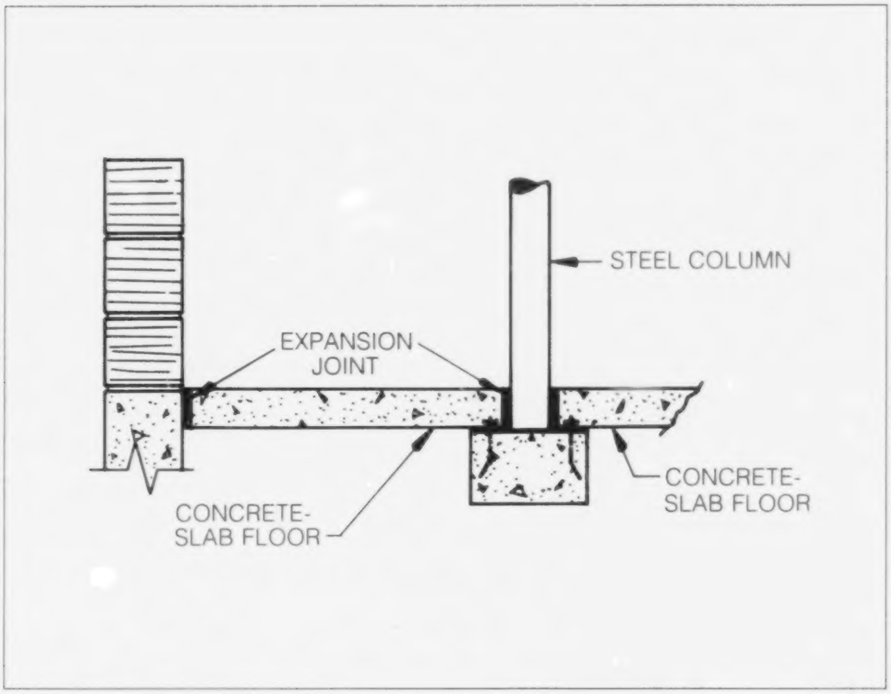

SNOW AND ICE
(LIVE LOAD)
BUILDING
MATERIALS
(DEAD LOAD)
FURNITURE
AND PEOPLE
(LIVE LOAD)
WINDS
(LATERAL
LOAD)
EARTH MOVEMENT
(LATERAL LOAD)

INFORMATION SHEET

d. **Expansion and contraction**—Naturally occurring forces caused by the expansion and contraction of the various building materials used in a structure

NOTE: The expansion and contraction of building materials due to changes in temperature necessitate the use of expansion joints between adjoining parts of a structure. Expansion joints (see Figure 8) may be made of any material that allows space for movement within the structure. Without expansion joints, a structure would crack, rupture, or be damaged in many other ways.

FIGURE 8



5. **Major components of a structural system and their definitions**

NOTE: Regardless of its size or complexity, every man-made structure is comprised of two major structural systems—a substructure and a superstructure.

a. **Substructure**—Foundation that supports upper portion (superstructure) of a structure by transmitting loads down to soil

NOTE: Substructures can be made of various materials (concrete, wood, steel) and, except in certain types of terrains, are usually constructed below ground

b. **Superstructure**—Any portion of a structure that rests upon the foundation (substructure)

INFORMATION SHEET

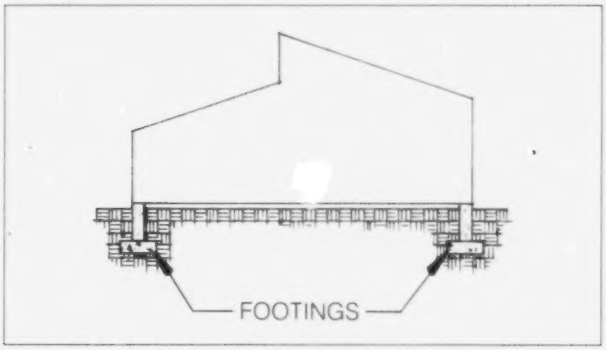
6. Basic components of a substructure (foundation) and their purposes

NOTE: A properly designed foundation is vital because it serves as the support base for the entire structure. Soil conditions and terrain determine the various types of foundation members to be used.

a. **Footing** (Figure 9)—Base of foundation; acts to distribute building's weight load directly to earth

NOTE: The footing, which sets at the very base of the foundation wall, acts to evenly distribute a structure's weight over a large area. Almost all footings are concrete so as to enable the footing to maintain firm contact with the earth's surface.

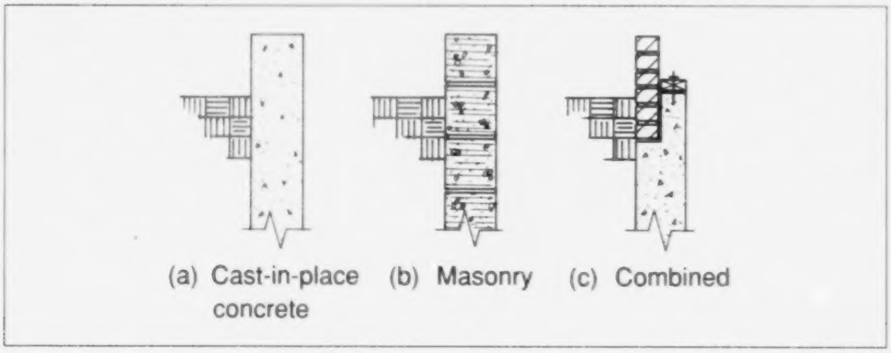
FIGURE 9



b. **Foundation wall**—Vertical component of foundation; acts to transmit building's weight load from superstructure to footings at base of foundation

NOTE: Foundation walls are normally constructed of cast-in-place concrete or masonry products such as concrete block (see Figure 10). Foundation-wall thicknesses are determined from engineering calculations, but, as a rule, will never be less than the thickness of the structure's exterior wall.

FIGURE 10


(a) Cast-in-place concrete (b) Masonry (c) Combined

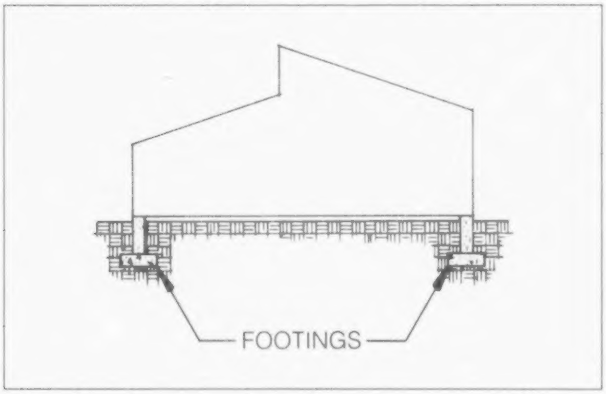
INFORMATION SHEET

7. Types of footings

a. **Spread** (T, continuous) (Figure 11)

NOTE: A spread footing, sometimes called a *T* or *continuous footing*, is usually rectangular and typically the same height but twice as wide as the foundation wall. When placed at the base of a foundation wall, the footing spreads out and forms an inverted-T shape with the foundation wall, hence the footing name *spread footing*.

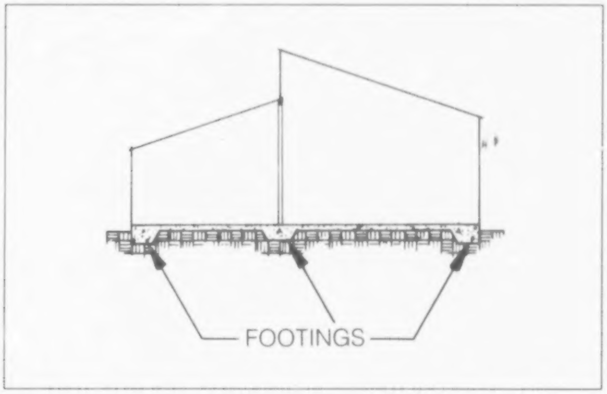
FIGURE 11



b. **Slab** (grade-beam) (Figure 12)

NOTE: A slab foundation combines the footing and foundation into a monolithic slab of concrete. The slab is widened and/or deepened where extra foundation support is required, such as at exterior walls or for interior column supports.

FIGURE 12

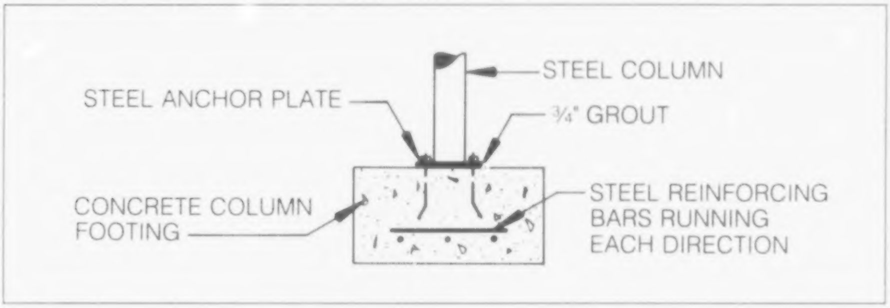


INFORMATION SHEET

c. **Column** (Figure 13)

NOTE: Column footings have rectangular concrete support bases that provide load distribution from interior building columns and other load-bearing supports. This type of footing is usually strengthened with steel reinforcing placed inside the footing. Footings are usually entirely concrete, while columns may be steel, wood, or brick.

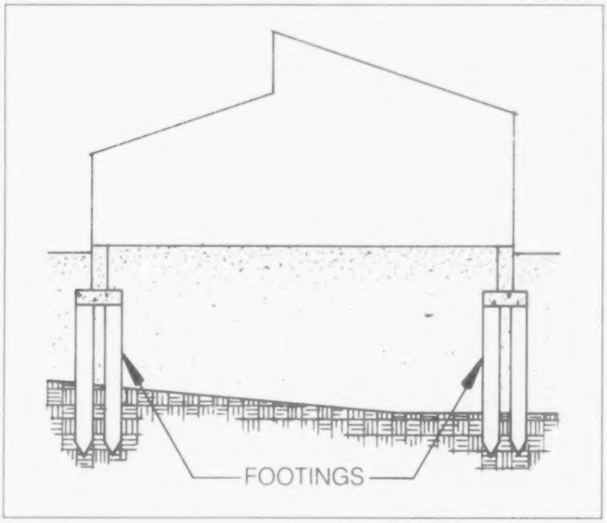
FIGURE 13


STEEL COLUMN
STEEL ANCHOR PLATE
¾" GROUT
CONCRETE COLUMN FOOTING
STEEL REINFORCING BARS RUNNING EACH DIRECTION

d. **Pile** (Figure 14)

NOTE: Pile footings are used when soil conditions are fragile, such as in sand or marsh areas or near bodies of water. In such areas, long, narrow supports made of steel, wood, or concrete are driven through the soft soil until they reach compacted soil or bedrock. Then a spread footing (called a *pile cap*) is placed over the pile footing.

FIGURE 14



INFORMATION SHEET

8. Types of information shown on a foundation plan

NOTE: A foundation plan is required to indicate dimensional information and callouts for a building's substructure. This plan view represents a horizontal section taken through the foundation just below the top of the foundation wall (see Figure 15). Below is a list of the required information shown on a foundation plan.

a. **Material-symbol hatching**

b. **Floor-surface callout**

c. **Indication of unexcavated areas**

d. **Height, width, and depth of support-column footings**

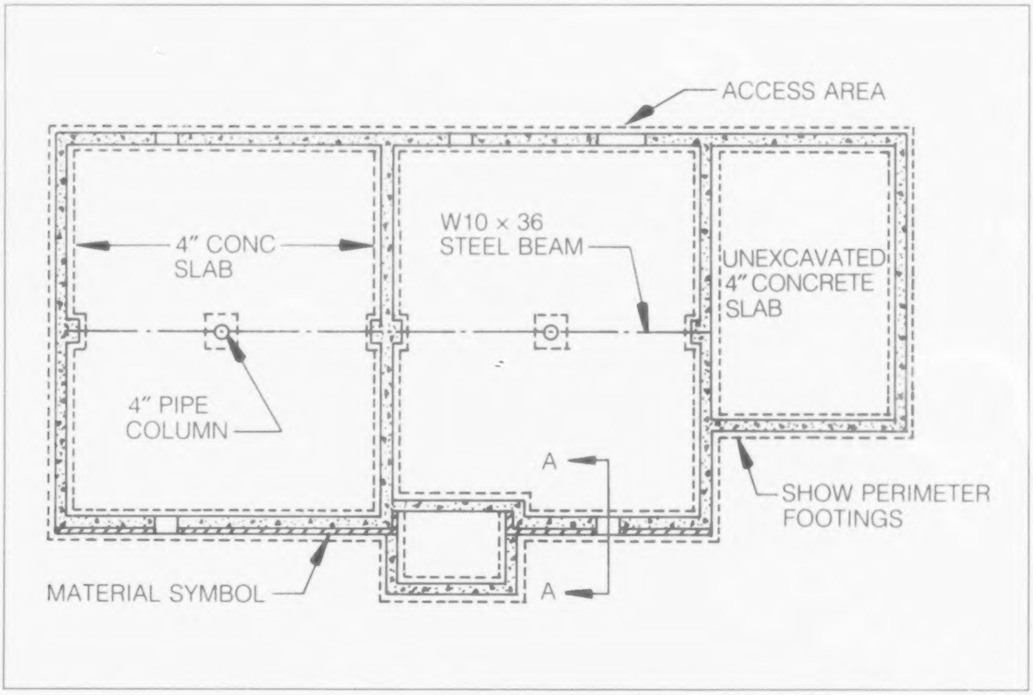
e. **Access areas or vents**

f. **Indication of perimeter footings**

g. **All necessary dimensions**

EXAMPLES: Foundation-wall thicknesses, locational dimensions, support-column locations, support-beam sizes and locations

FIGURE 15


ACCESS AREA
4" CONC SLAB
W10 × 36 STEEL BEAM
UNEXCAVATED 4" CONCRETE SLAB
4" PIPE COLUMN
A
SHOW PERIMETER FOOTINGS
MATERIAL SYMBOL
A

INFORMATION SHEET

9. **Basic types of superstructures and their descriptions**

   a. **Mass superstructure**—Superstructure comprised of large amounts of materials over great area with little or no internal openings

      EXAMPLES: Dams, retaining walls, monuments

   b. **Bearing-wall superstructure**—Superstructure comprised of continuous support walls normally made of masonry materials

   c. **Framed superstructure**—Superstructure comprised of steel, concrete, or wood columns or posts to create support skeleton

      NOTE: A framed superstructure supports all of the exterior materials used to enclose a structure and allows for the greatest amount of design freedom.

10. **Factors considered in commercial roof design**

    NOTE: The roof is an integral part of overall superstructure design—the roof combines with the structure's exterior walls to provide for the building's load-bearing capabilities and lateral support. The factors that are considered in the design of a roof are listed below.

    a. **Type of roof to be constructed**

       EXAMPLES: Flat, gable, hip, folded-plate, shed

    b. **Type of framing material to be used**

       EXAMPLES: Steel, concrete, combination of steel and concrete

    c. **Type of roof covering to be used**

       NOTE: A wide range of materials is used in roof coverings. Selection of these products is based upon the roof type, climatic conditions of the construction site, the required lifetime of the roof product, and cost.

    d. **Other roof components to be included**

       EXAMPLES: Downspouts, drainage columns, overhangs, parapet walls

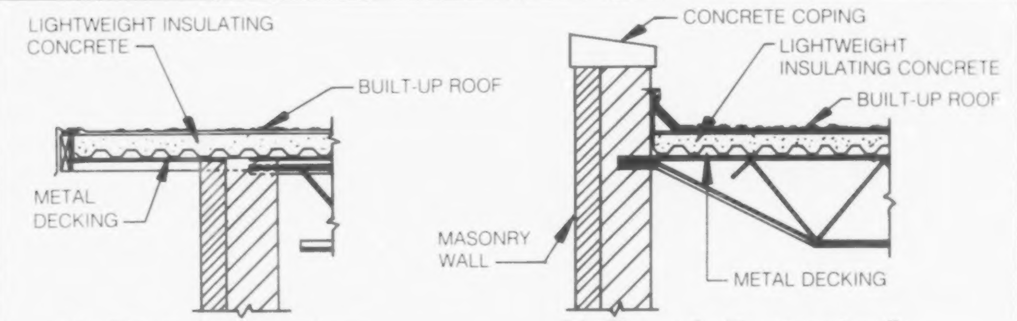
11. **Types of roofs**

    a. **Flat** (see Figure 16)

       NOTE: A flat roof is never actually flat because it has to drain. A roof is defined as *flat* if its pitch is less than 3 inches in 12 inches. The vast majority of commercial buildings have flat roofs. Flat roofs are economical and easy to construct, allow for unrestricted interior-space planning, and are normally constructed with either a parapet wall or an overhang for appearance and functionality.

INFORMATION SHEET

FIGURE 16


LIGHTWEIGHT INSULATING CONCRETE
BUILT-UP ROOF
METAL DECKING
CONCRETE COPING
LIGHTWEIGHT INSULATING CONCRETE
BUILT-UP ROOF
MASONRY WALL
METAL DECKING

(a) Flat roof with overhang (b) Flat roof with parapet wall

b. **Sloped**

NOTE: Sloped roofs in the various styles shown in Figure 17 below are used primarily in residential designs and are constructed from wood products.

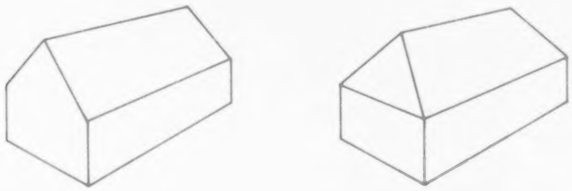
(1) Gable

(2) Hip

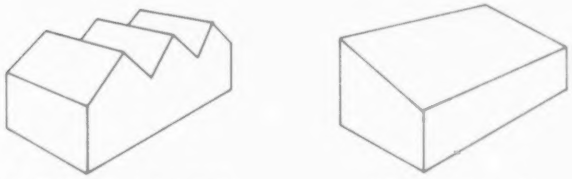
(3) Folded-plate

(4) Shed

FIGURE 17



(a) Gable roof (b) Hip roof



(c) Folded-plate roof (d) Shed roof

INFORMATION SHEET

12. **Types of materials used as roof framing members** (Figure 18)

    a. **Steel products**

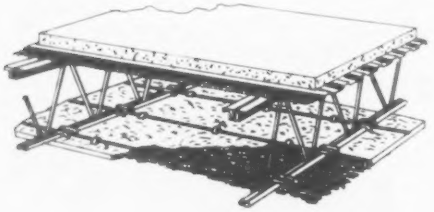
    NOTE: Steel beams, steel purlins, steel decking, support columns, and steel joists are used to construct simply-erected, cost-efficient flat roofs.

    b. **Precast-concrete products**

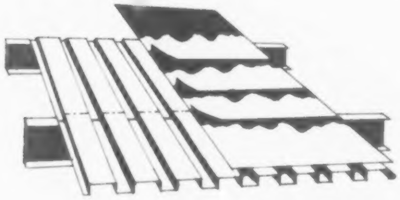
    NOTE: Precast concrete in the form of beams, joists, decking, or panels of unlimited lengths and sizes are also commonly used in constructing flat roofs.

    c. **Combination steel and concrete products**

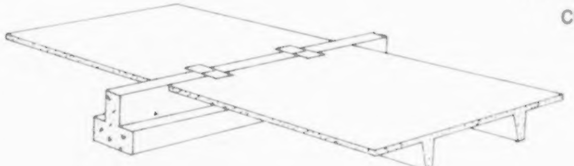
FIGURE 18



(a) Open-web steel joists with concrete decking



(b) Steel decking with composition roofing



(c) Concrete double tees used as part of roof construction

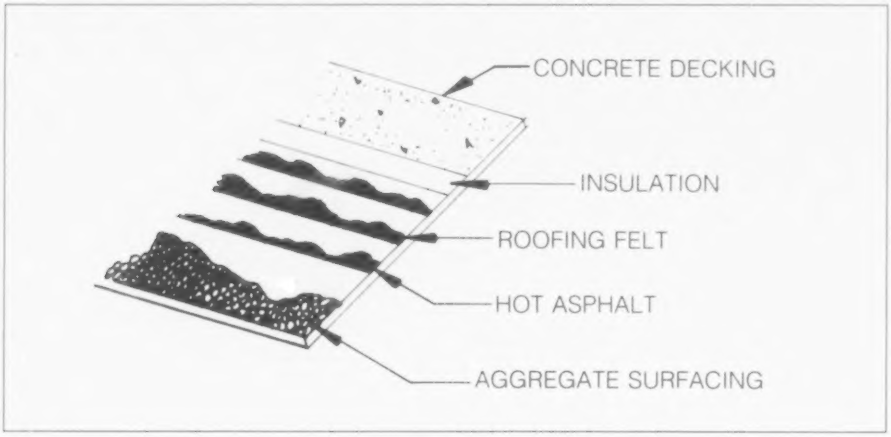
INFORMATION SHEET

13. **Types of materials used as roof coverings and their descriptions**

    a. **Single-ply roofing**—Roof covering material composed of flexible sheets of synthetic rubber or poly-vinyl chloride (PVC)

    b. **Built-up roofing** (composition roofing) (Figure 19)—Roof covering composed of layers of felt or plastic sheeting, hot-asphalt covering, and gravel or other aggregate; used to ensure a watertight seal on flat roofs

    FIGURE 19



    c. **Roofing shingles**—Roof material composed of thin pieces of wood, asphalt-saturated felt, fiberglass, or other material; used primarily on sloping (pitched) roofs

    d. **Tile roofing**—Thin finish material made from concrete or fired clay; used to create a different architectural style for sloping roofs

    e. **Metal roofing**—Roofing material composed of copper, aluminum, or galvanized iron; generally used for architectural style on more expensive structures

14. **Other roof components to be considered in commercial roof design and their descriptions**

    a. **Drainage components**—Downspouts or drainage columns used to provide drainage for structures with flat roofs or to direct water on sloping roofs

    b. **Overhangs**—Horizontal projections beyond the vertical face below; used to provide shade from the afternoon sun and to lend to the structure's overall appearance

    c. **Parapet walls**—Low walls or short extensions above the finished roof line; used to hide mechanical equipment mounted on the roof, give structure a more impressive appearance, and help direct water drainage from the roof

INFORMATION SHEET

15. **Types of information shown on a roof framing plan** (Figure 20)

NOTE: A roof framing plan is drawn as a plan view of a roof with the roof coverings removed, exposing the structural members below. Each of the structural members are identified by type, size, weight, and any other necessary information. When structural-steel members are to be used in roof construction, the roof framing plan is drawn using a single-line method to represent the members. Listed below is the necessary information that must be indicated on a roofing plan.

a. **Type of structural member**

b. **Size of structural member**

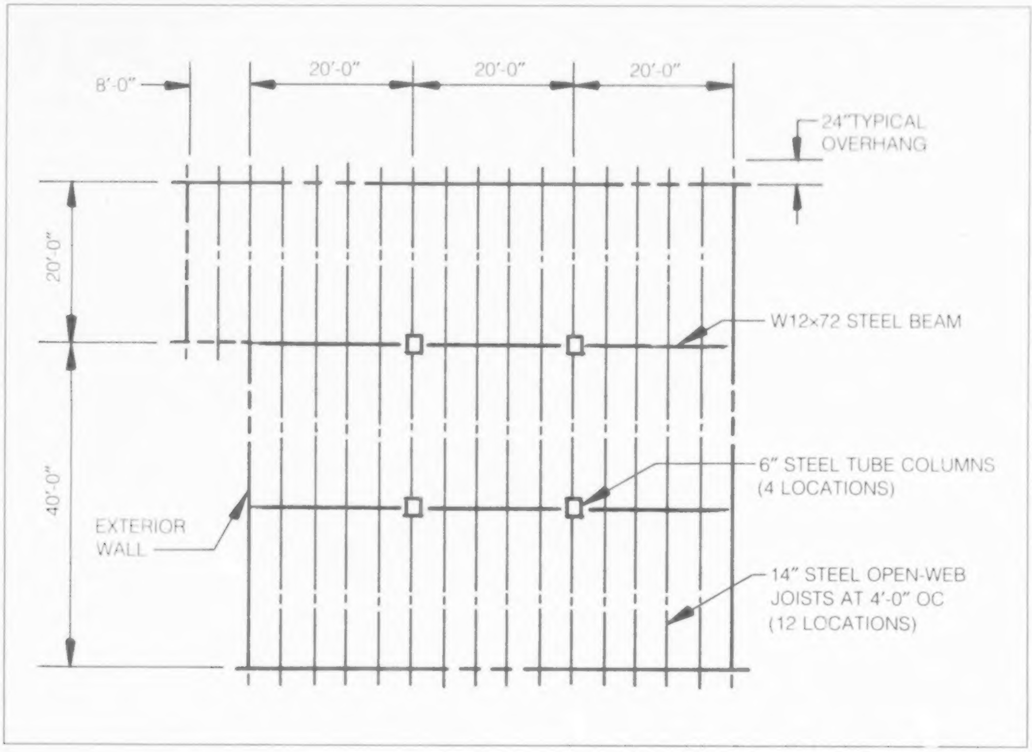
c. **Center-to-center spacing of members**

d. **Overhang dimensions** (if an overhang is included)

e. **Overall dimensions**

f. **Exterior walls shown for reference**

FIGURE 20


8'-0"
20'-0"
20'-0"
20'-0"
24" TYPICAL OVERHANG
20'-0"
W12×72 STEEL BEAM
40'-0"
6" STEEL TUBE COLUMNS (4 LOCATIONS)
EXTERIOR WALL
14" STEEL OPEN-WEB JOISTS AT 4'-0" OC (12 LOCATIONS)

STRUCTURAL SYSTEMS
UNIT 6

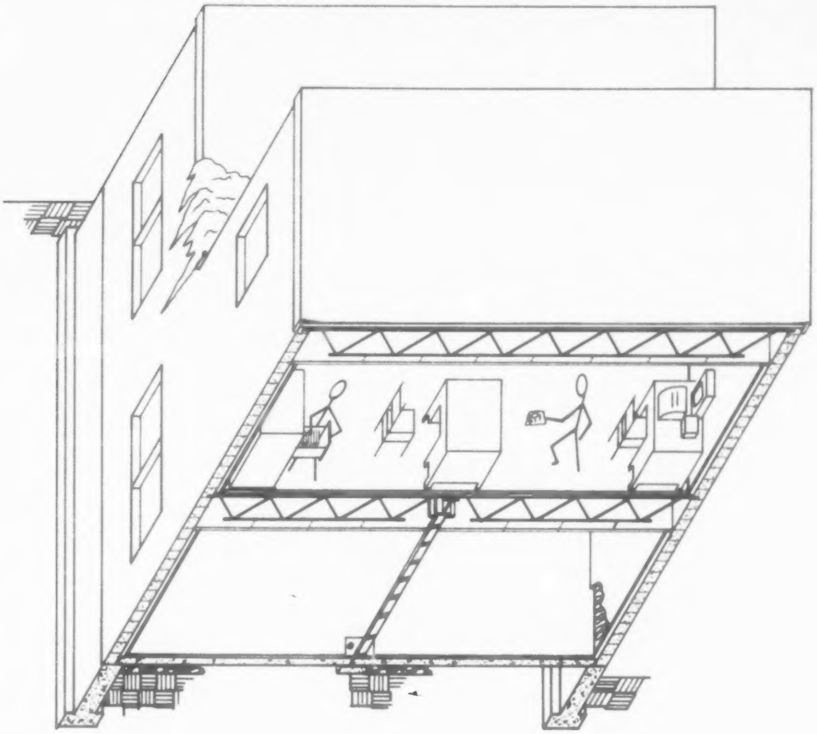
ASSIGNMENT SHEET 1—ANALYZE THE EFFECTS OF STRUCTURAL FORCES ON BUILDING DESIGN

Name ______________________________ Score ______________

Introduction When creating an effective structural design, an architect must take into account all the forces that affect the building. An understanding of what these forces are will aid a drafter in realizing why certain materials have been selected for a given design.

Exercise

Directions Study the sectioned drawing of the commercial building shown in the illustration below. Then complete each of the items on the following page.



ASSIGNMENT SHEET 1

1. What live loads might occur within the structure illustrated on the previous page? (Give at least four examples.)

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

2. Soil expansion and soil contraction are considered external horizontal forces. As such, soil expansion and contraction are what type of load? (Circle the correct answer below.)

   a. Live load
   b. Dead load
   c. Lateral load

3. What unit of measure is used in determining the amount of force acting upon a structure?

   Unit of measure ______________________________

   ____

4. What objects make up the vast majority of the structure's dead load?

   ____

5. What building material used in this structure is designed to prevent cracking, rupturing, or other damage from external forces?

   ____

STRUCTURAL SYSTEMS
UNIT 6

ASSIGNMENT SHEET 2—DEVELOP A FOUNDATION PLAN

Name ______________________________ Score ______________

Introduction In Objective 8, you learned the types of information shown on a foundation plan and that a *foundation plan* represents a horizontal section taken through the foundation just below the top of the foundation wall. In this assignment sheet, you will practice the skills needed in drawing a foundation plan.

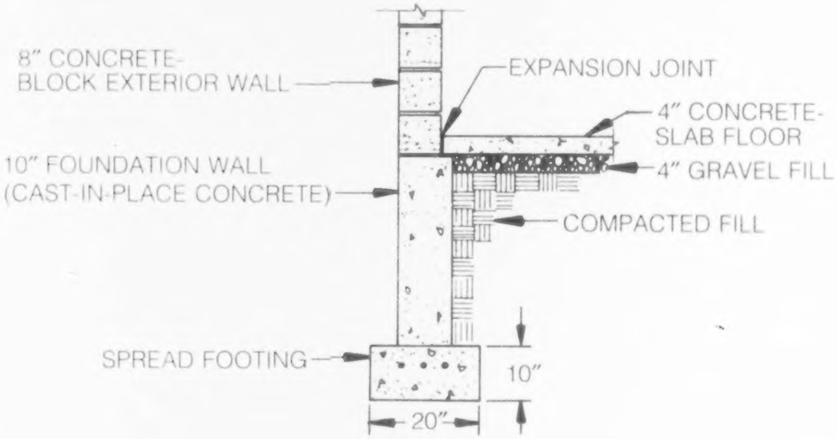
Exercise

Directions In Unit 4, Assignment Sheets 3 and 4, you developed a floor plan and an elevation plan for a proposed fire station, and in Unit 5, Assignment Sheet 5, you selected necessary section views from your floor plan. Review these plans, and study the criteria and the sketch presented below. Then using the dimensional information used to draw the floor plan, develop a complete foundation plan for the fire station.

Criteria

- Show a foundation wall around the perimeter of the building.
- Show the garage with a separate foundation wall.
- Show column footings of the following dimensions—18″×18″×10″ deep with concrete pads.
- Show top of footing at a minimum of 24 inches below grade line.
- Use a spread footing as shown in the sketch below.

Sketch


8″ CONCRETE-BLOCK EXTERIOR WALL
EXPANSION JOINT
4″ CONCRETE-SLAB FLOOR
4″ GRAVEL FILL
10″ FOUNDATION WALL (CAST-IN-PLACE CONCRETE)
COMPACTED FILL
SPREAD FOOTING
10″
20″

STRUCTURAL SYSTEMS
UNIT 6

ASSIGNMENT SHEET 3—DEVELOP REQUIRED FOUNDATION SECTIONS

Name ______________________________ Score ______________

Introduction

Foundation sections are required to show specific information about the foundation that were too small to be indicated on the foundation plan. Foundation sections also provide a vertical plane of viewing (height dimensions) as opposed to the plan view shown in a foundation drawing.

Exercises

Part A

Directions

Review the foundation plan of the fire station you completed in Assignment Sheet 2 of this unit, and determine the foundation sections required for this plan. Indicate required foundation sections by placing cutting-plane lines at the proper locations on the foundation plan.

Part B

Directions

On the blanks provided below, explain why you placed cutting-plane lines where you did on the foundation plan. Then discuss your explanation with your instructor.

____

____

____

____

____

____

____

____

____

____

____

ASSIGNMENT SHEET 3

Part C

Directions

After your instructor has approved the placement of the cutting-plane lines on your floor plan, draw the required sections at an appropriate scale. Completely dimension, label, and reference all the required drawings.

STRUCTURAL SYSTEMS
UNIT 6

ASSIGNMENT SHEET 4—DEVELOP A ROOF FRAMING PLAN

Name ______________________ Score ____________

Introduction

In developing a roof framing plan, you will need to gather information from the floor plan and various section drawings (longitudinal, transverse, wall). These drawings will provide the structural-member sizes, types, and spacings needed to create the roof framing plan.

Exercise

Directions

Review the floor plan for the fire station you developed in Unit 4 and the various section drawings you have developed in Unit 5 and in this unit. Then study the supplemental information presented below and develop a roof-framing plan for the fire station.

Supplemental information

- The 12-inch-deep steel bar joists are to be called out specifically as "12H6." They will be spaced 4′-0″ OC throughout the building.
- The W8×20 steel beams run from support column to support column where they are bolted together with a splice plate.

STRUCTURAL SYSTEMS
UNIT 6

WRITTEN TEST

Name ______________________________ Score ______________

1. Match terms associated with structural systems to their correct definitions. Write the numbers on the blanks provided.

______a. Separation between adjoining sections of a concrete slab to allow movement caused by expansion and contraction

______b. Large sections of walls, floors, beams, or other structures formed and poured in other than their final position

______c. Horizontal support that spans across adjacent beams

______d. Load-bearing vertical structural member with a height at least three times its largest diameter

______e. Building method in which stretched steel cables are put in tension and then concrete is placed over cables to form a concrete slab or other concrete structure

______f. Structural member consisting of a large, single piece of concrete

______g. Light-gage metal sheets used to construct a floor or deck form, or used as floor or deck members; wood members used as finish surface of a deck

______h. Non-load-bearing exterior surface

1. Column
2. Decking
3. Expansion joint
4. Monolithic slab
5. Precast concrete
6. Prestressed concrete
7. Purlin
8. Veneer

2. Define the term *structural system*. Write your answer on the blanks provided below.

Structural system ____

____

____

____

WRITTEN TEST

3. List 4 of the 6 types of materials used in structural systems. Write your answers on the blanks provided below.

a. ______________________ c. ______________________

b. ______________________ d. ______________________

4. State descriptions of the types of forces exerted on a structural system. Write your answers on the blanks provided beside each of the terms below.

a. Live loads ______________________________________

____

b. Dead loads ______________________________________

____

c. Lateral loads ______________________________________

____

d. Expansion and contraction ______________________________________

____

5. State definitions of the major components of a structural system. Write your answers on the blanks provided beside each of the terms below.

a. Substructure ______________________________________

____

b. Superstructure ______________________________________

____

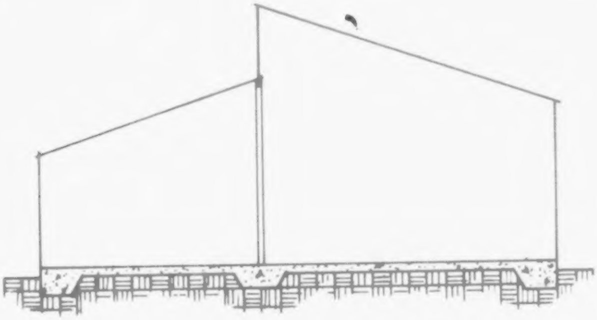
6. Distinguish between the purposes of the basic components of a substructure. Put an *F* in the blank before the purpose of a *footing* and a *FW* in the blank before the purpose of a *foundation w*

_____a. Vertical component of foundation; acts to transmit building's weight load from superstructure to footings at base of foundation

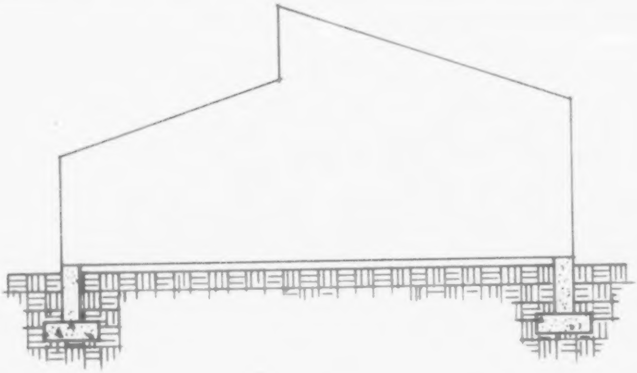
_____b. Base of foundation; acts to distribute building's weight load directly to earth

WRITTEN TEST

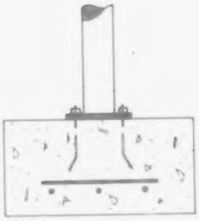
7. Label the types of footings shown in the illustrations below. Write your answers on the blanks provided below each of the illustrations.



a. ____________________

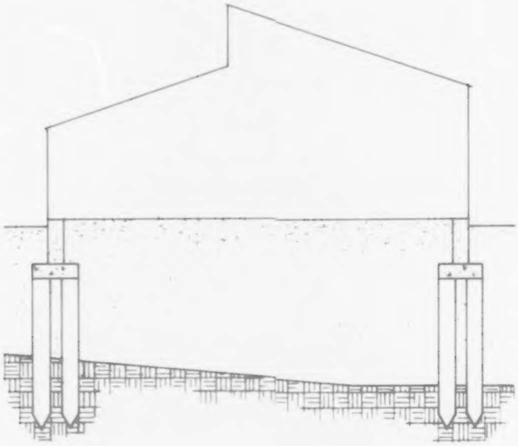


b. ____________________



c. ____________________

WRITTEN TEST



d. ______________________________

8. List 5 of the 7 types of information shown on a foundation plan. Write your answers on the blanks provided below.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

9. Match basic types of superstructures to their correct descriptions. Write the numbers on the blanks provided.

_____a. Superstructure comprised of continuous support walls normally made of masonry materials

_____b. Superstructure comprised of steel, concrete, or wood columns or posts to create support skeleton

_____c. Superstructure comprised of large amounts of materials over great area with little or no internal openings

1. Mass superstructure
2. Bearing-wall superstructure
3. Framed superstructure

WRITTEN TEST

10. List 3 of the 4 factors considered in commercial roof design. Write your answers on the blanks provided below.

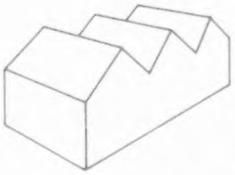
    a. ______________________________

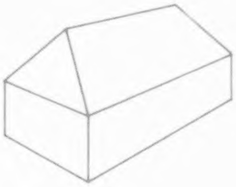
    b. ______________________________

    c. ______________________________

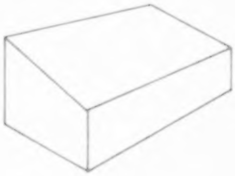
11. Identify types of roofs shown in the illustrations below. Write your answers on the blanks below each of the illustrations.

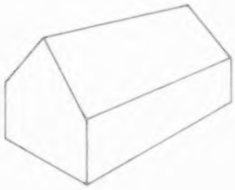
Gable **Folded-plate** **Flat** **Hip** **Shed**





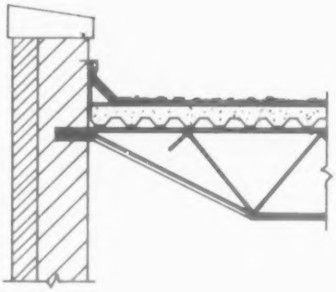
a. ______________________ b. ______________________





c. ______________________ d. ______________________

WRITTEN TEST



e. ______________________

12. List types of materials used as roof framing members. Write your answers on the blanks provided below.

a. ______________________

b. ______________________

c. ______________________

13. Match types of materials used as roof coverings to their correct descriptions. Write the numbers on the blanks provided.

_____a.	Roof covering composed of layers of felt or plastic sheeting, hot-asphalt covering, and gravel or other aggregate; used to ensure a watertight seal on flat roofs	1. Single-ply roofing
_____b.	Roofing material composed of copper, aluminum, or galvanized iron; generally used for architectural style on more expensive structures	2. Built-up roofing
_____c.	Thin finish material made from concrete or fired clay; used to create a different architectural style for sloping roofs	3. Roofing shingles
_____d.	Roof material composed of thin pieces of wood, asphalt-saturated felt, fiberglass, or other material; used primarily on sloping roofs	4. Tile roofing
_____e.	Roof covering material composed of flexible sheets of synthetic rubber or poly-vinyl chloride	5. Metal roofing

WRITTEN TEST

14. Distinguish among the descriptions of other components to be considered in commercial roof design. Write a *D* in the blank before the description of *drainage components*, write an *O* before the description of *overhangs*, and write a *P* before the description of *parapet walls*.

_____a. Low walls or short extensions above the finished roof line; used to hide mechanical equipment mounted on the roof, give structure a more impressive appearance, and help direct water drainage from the roof

_____b. Downspouts or drainage columns used to provide drainage for structures with flat roofs or to direct water on sloping roofs

_____c. Horizontal projections beyond the vertical face below; used to provide shade from the afternoon sun and to lend to the structure's overall appearance

15. List the types of information shown on a roof framing plan. Write your answers on the blanks provided below.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

ARCHITECTURAL DIMENSIONING
UNIT 7

UNIT OBJECTIVE

After completing this unit, the student should be able to use standard architectural dimensioning techniques to dimension working drawings and complete or identify statements concerning metric and modular dimensioning techniques. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with dimensioning to their correct definitions.
2. Complete statements concerning standard architectural-drafting dimensioning techniques.
3. Select true statements concerning metric-system dimensioning techniques.
4. Complete statements concerning modular-drafting drawing and dimensioning techniques.
5. Practice using standard architectural-drafting dimensioning techniques. (Assignment Sheet 1)
6. Dimension a floor plan. (Assignment Sheet 2)
7. Dimension a foundation plan. (Assignment Sheet 3)
8. Dimension an elevation drawing. (Assignment Sheet 4)
9. Dimension a plot plan. (Assignment Sheet 5)
10. Dimension section drawings. (Assignment Sheet 6)

ARCHITECTURAL DIMENSIONING
UNIT 7

SUGGESTED ACTIVITIES

Preparation

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery and Application" section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.

- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section.
- Make transparencies from the transparency masters included in this unit.
- Prepare classroom and lab. Put up posters, charts, and signs; display articles and other references related to the objectives of this unit.

Delivery and Application

Unit introduction

- Provide students with objective sheet. Discuss unit and specific objectives.
- Show the film *Architectural Drawing*—Part 1, "Lines and Dimensions."
- Provide examples of architectural working drawings and hold a class discussion highlighting the obvious differences and similarities between basic technical dimensioning and architectural dimensioning.
- Provide students with information sheet.

Objective 1 Match terms associated with dimensioning to their correct definitions.

- Show examples that illustrate terms and make examples available in the classroom.

SUGGESTED ACTIVITIES

Objective 2 Complete statements concerning standard architectural-drafting dimensioning techniques.

- Draw on the chalkboard examples of instances where spacing would be a problem using a normal dimension line with the dimension inside the extension lines with arrowheads. Have students discuss alternative means of dimensioning the crowded areas. Lead discussion to include the items presented in the objective.
- Using Transparency 1, "Standard Architectural-Drafting Dimensioning Techniques," explain and then give guidelines and examples of architectural dimensioning techniques.
- Hand out Assignment Sheet 1, "Practice Using Standard Architectural-Drafting Dimensioning Techniques." Read with students the introduction to the assignment and discuss the directions and building criteria. Answer any student questions, and then have students complete Assignment Sheet 1.

Objective 3 Select true statements concerning metric-system dimensioning techniques.

- Read with students the note introducing the objective. Emphasize to students the importance of becoming familiar with the metric system because of the shift toward a global economy and the corresponding pressures on the United States to convert from the United States Customary System.
- Use Transparency 2, "Metric Dimensioning Techniques," to illustrate the proper methods of dimensioning using the metric system. Explain the mathematical conversion factors used to go from feet and inches to meters and millimeters.
- Have students convert one floor-plan drawing and one detail drawing from the U. S. Customary System to the metric system.

Objective 4 Complete statements concerning modular-drafting drawing and dimensioning techniques.

- Read with students the note introducing the objective. Then, hold a class discussion concerning the advantages and disadvantages of modular design.
- Show examples on the chalkboard explaining the drafting and dimensioning guidelines associated with modular design.

SUGGESTED ACTIVITIES

Assignment Sheets 2 through 6

Assignment Sheet 2

- Hand out Assignment Sheet 2, "Dimension a Floor Plan," and Student Supplement 1, "Guidelines for Dimensioning Floor-Plan Drawings." Read with students Student Supplement 1, explaining the importance of an accurately dimensioned floor plan in preventing costly errors that create rework time and/or material waste.
- Discuss and show examples of how to dimension to various building materials (i.e., frame and masonry) and explain why it is important that materials be dimensioned in that manner.
- Have students locate the floor plan of the fire station they completed in Unit 4, Assignment Sheet 3.
- Discuss Assignment Sheet 2. Answer any student questions and then have students complete Assignment Sheet 2.

Assignment Sheet 3

- Hand out Assignment Sheet 3, "Dimension a Foundation Plan." Discuss and show examples of how to dimension foundation plans.
- Have students locate the foundation plan of the fire station they completed in Unit 6, Assignment Sheet 2.
- Discuss Assignment Sheet 3. Answer any student questions and then have students complete Assignment Sheet 3.

Assignment Sheet 4

- Hand out Assignment Sheet 4, "Dimension an Elevation Drawing," and Student Supplement 2, "Guidelines for Dimensioning Elevation Drawings."
- Using Transparency 3, "Dimensioning an Elevation Drawing," discuss the aspects of dimensioning an elevation drawing. Explain the concepts of datum lines and datum targets and how they are applied to an elevation view.
- Have students locate the elevation drawing of the fire station they completed in Unit 4, Assignment Sheet 4.
- Discuss Assignment Sheet 4. Answer any student questions and then have students complete Assignment Sheet 4.

SUGGESTED ACTIVITIES

Assignment Sheet 5

- Hand out Assignment Sheet 5, "Dimension a Plot Plan," and Student Supplement 3, "Guidelines for Dimensioning Plot-Plan Drawings."
- Using Transparency 4, "Dimensioning a Plot Plan," discuss the function of a plot plan and the information that must be provided when dimensioning a plot plan.
- Visit a commercial building with a well-defined lot. Have the students list all of the natural and man-made items that must be indicated on a plot plan for the building. Return to class and develop a master list to emphasize the importance and the amount of work that goes into a plot plan.
- Have students locate the plot plan of the fire station they completed in Unit 3, Assignment Sheet 3.
- Read with students the information in Student Supplement 3 and discuss Assignment Sheet 5. Answer any student questions and then have students complete Assignment Sheet 5.

Assignment Sheet 6

- Hand out Assignment Sheet 6, "Dimension Section Drawings," and Student Supplement 4, "Guidelines for Dimensioning Detail and Section Drawings."
- Using Transparency 5, "Dimensioning Detail/Section Drawings," discuss the required information that must be dimensioned on a detail/section drawing. Explain the use of callouts.
- Show students examples of detail/section drawings from commercial buildings to emphasize the complexity and completeness required in dimensioning detail/section drawings.
- Have students locate the foundation sections they completed for the fire station in Unit 6, Assignment Sheet 3.
- Read with students Student Supplement 4 and discuss Assignment Sheet 6. Answer any student questions and then have students complete Assignment Sheet 6.

Evaluation

- Give written test.
- Compile written-test and assignment-sheet scores on Unit Evaluation Form.

SUGGESTED ACTIVITIES

- Reteach and retest as required.

Suggested Resources

Resources used in developing unit

- Helper, D. E., and Paul Wallach. *Architecture, Drafting, and Design.* New York: McGraw-Hill, 1987.
- Muller, Edward J. *Architectural Drawing and Light Construction.* Englewood Cliffs, New Jersey: Prentice-Hall, 1985.
- Spence, William P. *Architecture: Design, Engineering, and Drawing.* Bloomington, Illinois: Glencoe-Bennett & McKnight, 1985.

Additional resources

Media

- *Architectural Drawing*—Part 1, "Lines and Dimensions." Order number, GU-997. Copyright 1989. Available on filmstrip or VHS cassette from Opportunities for Learning, Inc., 20417 Nordhoff Street, Dept. 1N, Chatsworth, California 91311.

  This media program is the initial title in a series about architectural drawing. "Lines and Dimensions" discusses standard architectural linework and dimensioning practices with emphasis on clarity and communication.

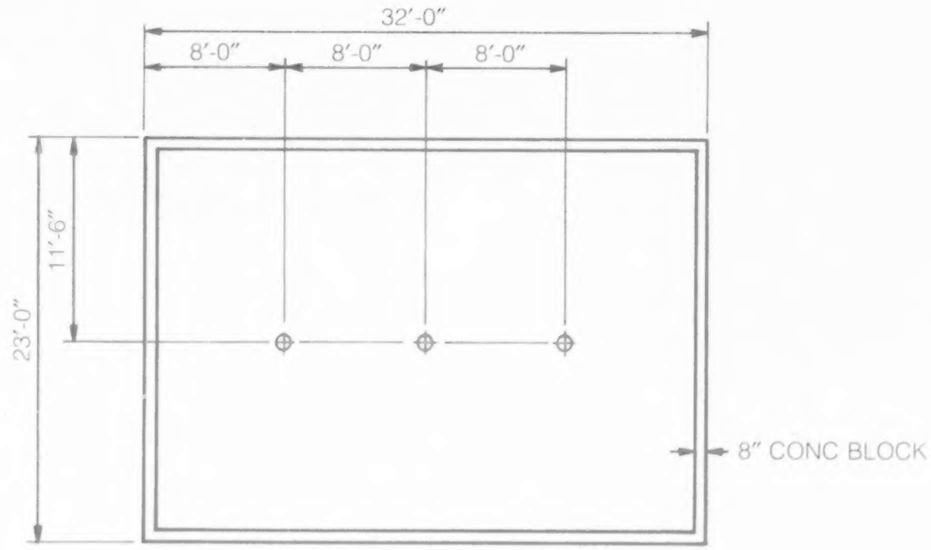
Print media

- Lewis, Jack R. *Architectural Draftsmans Reference Handbook.* Englewood Cliffs, New Jersey: Prentice-Hall, 1982.
- Putnam, Robert E. *Construction Blueprint Reading.* Reston, Virginia: Reston Publishing Co., 1985.

ARCHITECTURAL DIMENSIONING
UNIT 7

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1



Assignment Sheet 2	Evaluated to the satisfaction of the instructor.
Assignment Sheet 3	Evaluated to the satisfaction of the instructor.
Assignment Sheet 4	Evaluated to the satisfaction of the instructor.
Assignment Sheet 5	Evaluated to the satisfaction of the instructor.
Assignment Sheet 6	Evaluated to the satisfaction of the instructor.

ARCHITECTURAL DIMENSIONING
UNIT 7

ANSWERS TO WRITTEN TEST

1. a. 3
   b. 1
   c. 6
   d. 5
   e. 4
   f. 2

2. a. actual
   b. evenly
   c. height, size
   d. 12
   e. 12
   f. smallest, largest
   g. right
   h. above
   i. Extension
   j. dimension
   k. Hidden

3. b, c, d

4. a. 4
   b. building
   c. Arrowheads
   d. Dots

ARCHITECTURAL DIMENSIONING
UNIT 7

UNIT EVALUATION FORM

Student name ______________________________ Unit rating __________

Assignment sheet ratings

Assignment Sheet 1—Practice Using Standard Architectural-Drafting Dimensioning Techniques Rating __________

Comments: ______________________________

____

Assignment Sheet 2—Dimension a Floor Plan Rating __________

Comments: ______________________________

____

Assignment Sheet 3—Dimension a Foundation Plan Rating __________

Comments: ______________________________

____

Assignment Sheet 4—Dimension an Elevation Drawing Rating __________

Comments: ______________________________

____

Assignment Sheet 5—Dimension a Plot Plan Rating __________

Comments: ______________________________

____

Assignment Sheet 6—Dimension Section Drawings Rating __________

Comments: ______________________________

____

UNIT EVALUATION FORM

Written test scores

Pretest ____________ Other ____________

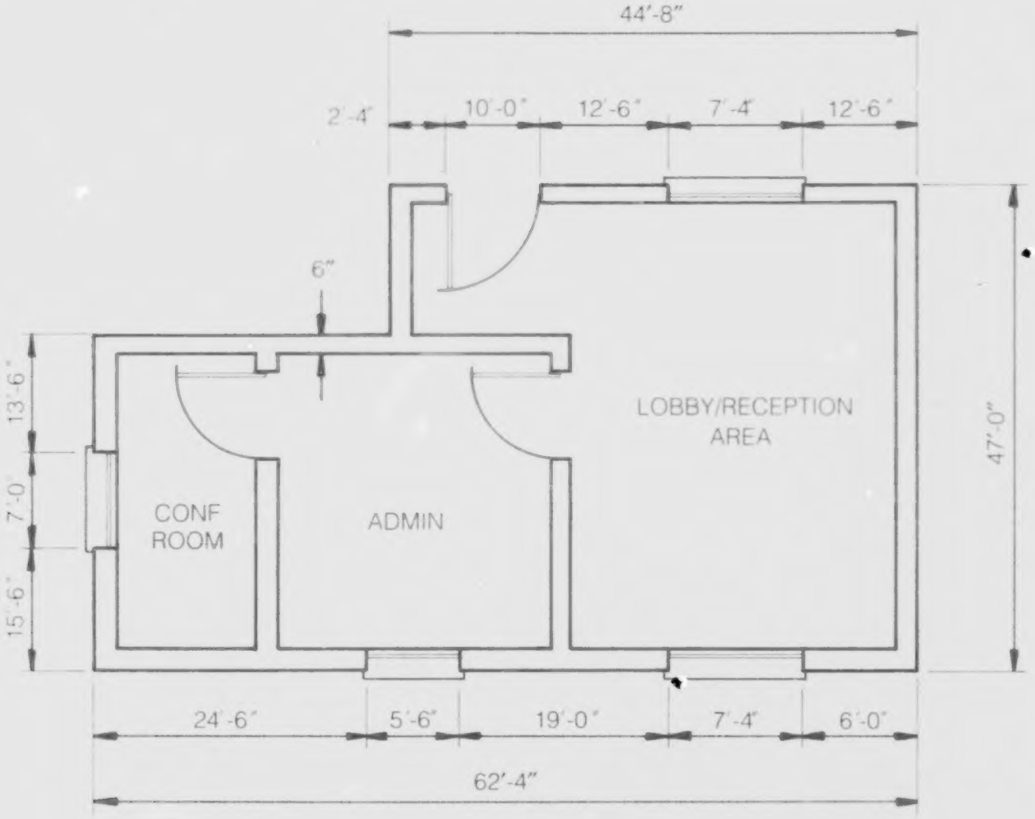
Posttest ____________

Instructor signature ______________________________________ Date ____________

Student signature ______________________________________ Date ____________

Duplication of this form is permitted.

Standard Architectural-Drafting Dimensioning Techniques


44'-8"
2'-4"
10'-0"
12'-6"
7'-4"
12'-6"
6"
13'-6"
7'-0"
15'-6"
47'-0"
LOBBY/RECEPTION AREA
CONF ROOM
ADMIN
24'-6"
5'-6"
19'-0"
7'-4"
6'-0"
62'-4"

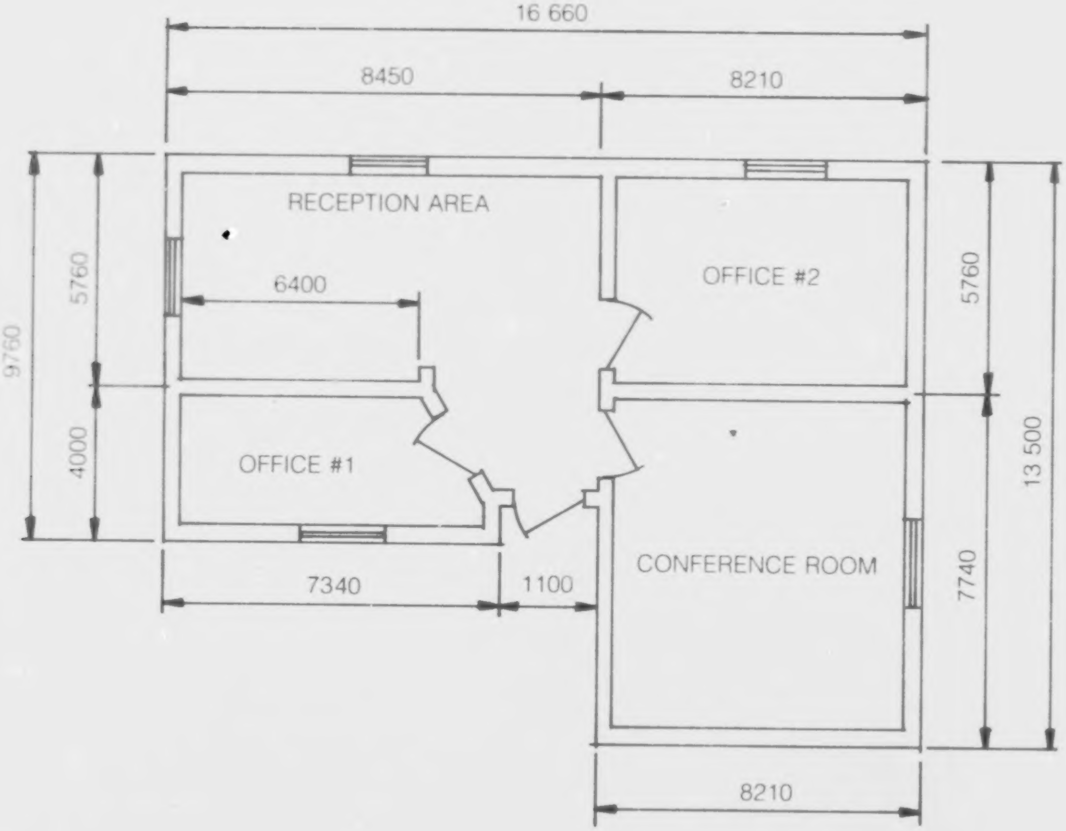
387

TM 1

386

AD-421

Metric Dimensioning Techniques


16 660
8450
8210
RECEPTION AREA
OFFICE #2
6400
5760
9760
4000
OFFICE #1
5760
13 500
CONFERENCE ROOM
7740
7340
1100
8210

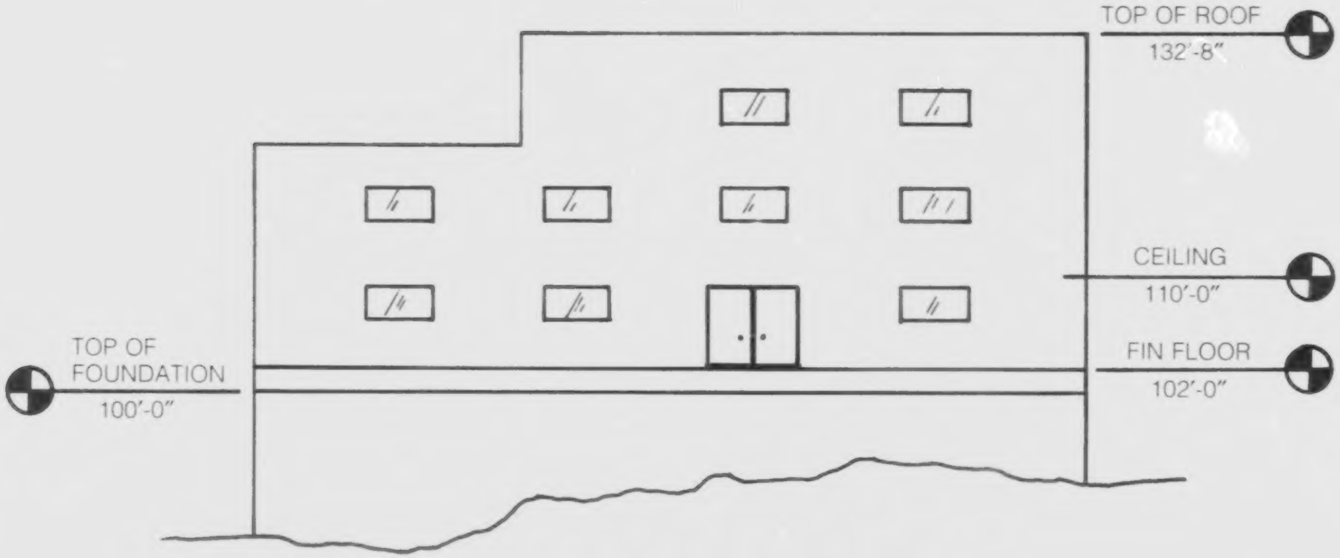
TM 2

355

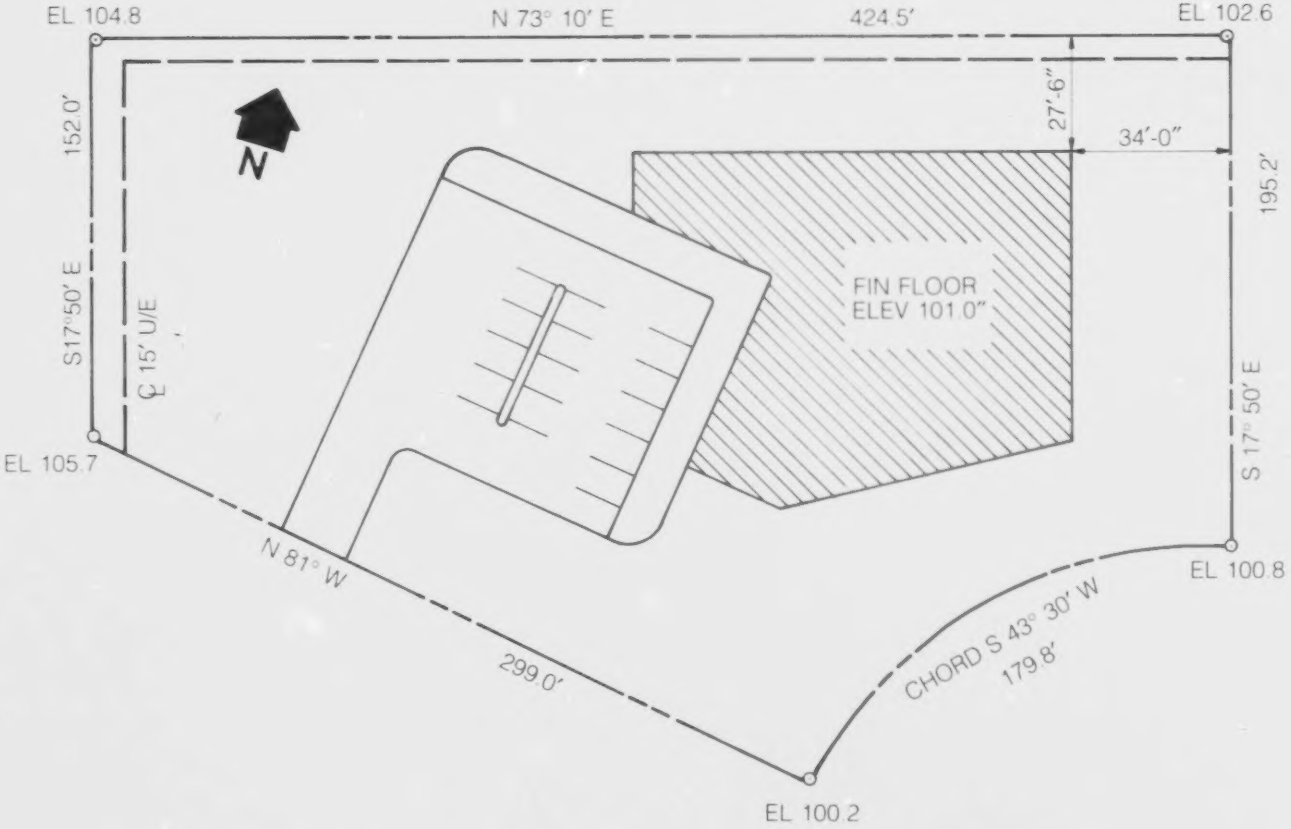
359

AD-423

Dimensioning an Elevation Drawing


TOP OF ROOF
132'-8"
CEILING
110'-0"
FIN FLOOR
102'-0"
TOP OF
FOUNDATION
100'-0"

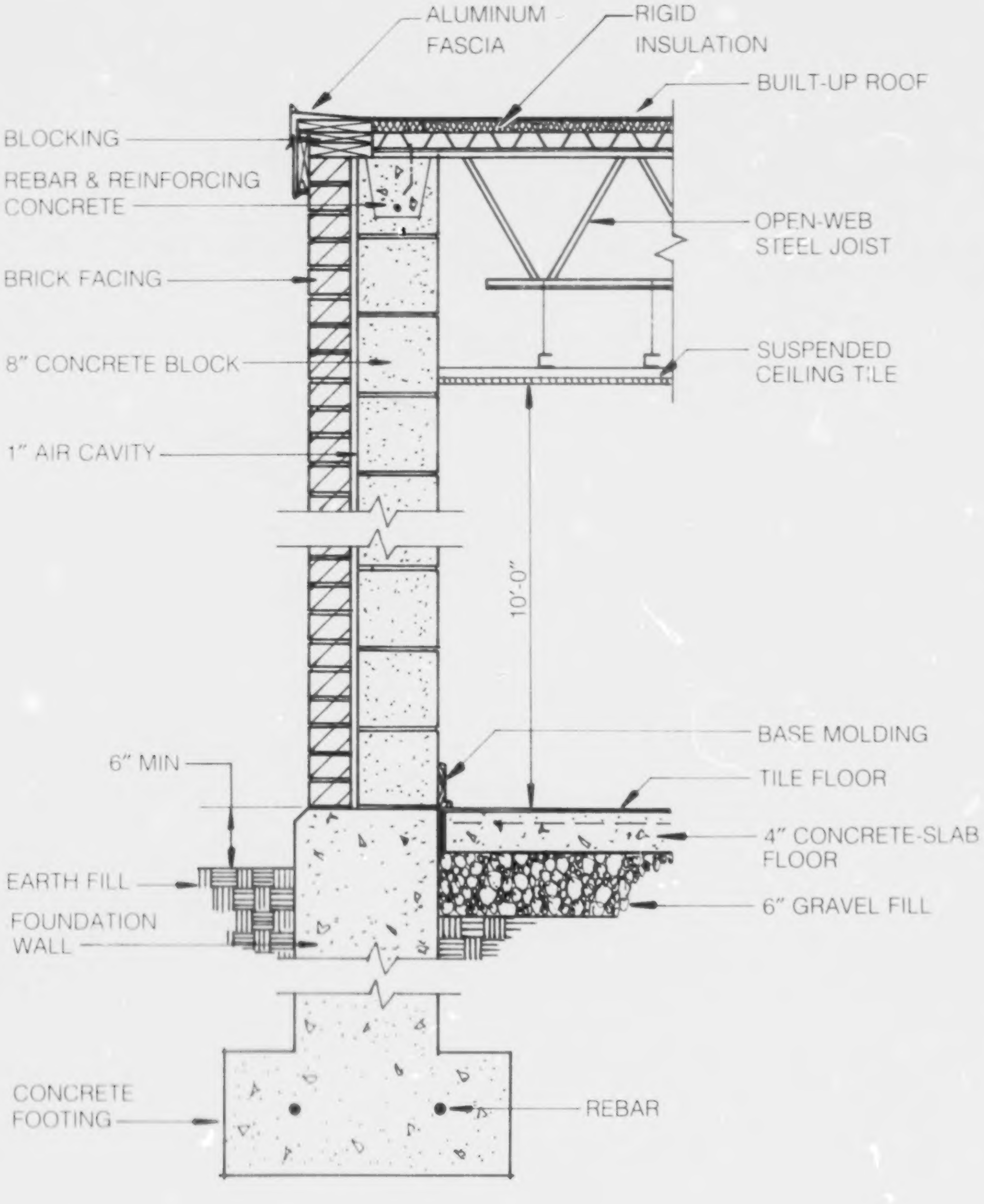
Dimensioning a Plot Plan


EL 104.8
N 73° 10′ E
424.5′
EL 102.6
152.0′
27′-6″
34′-0″
195.2′
N
S17°50′ E
℄ 15′ U/E
FIN FLOOR
ELEV 101.0″
S 17° 50′ E
EL 105.7
N 81° W
EL 100.8
CHORD S 43° 30′ W
179.8′
299.0′
EL 100.2

TM 4

AD-427

Dimensioning Detail/Section Drawings


ALUMINUM FASCIA
RIGID INSULATION
BUILT-UP ROOF
BLOCKING
REBAR & REINFORCING CONCRETE
OPEN-WEB STEEL JOIST
BRICK FACING
8" CONCRETE BLOCK
SUSPENDED CEILING TILE
1" AIR CAVITY
10'-0"
BASE MOLDING
6" MIN
TILE FLOOR
4" CONCRETE-SLAB FLOOR
EARTH FILL
FOUNDATION WALL
6" GRAVEL FILL
CONCRETE FOOTING
REBAR

ARCHITECTURAL DIMENSIONING
UNIT 7

INFORMATION SHEET

1. **Terms and definitions associated with dimensioning**

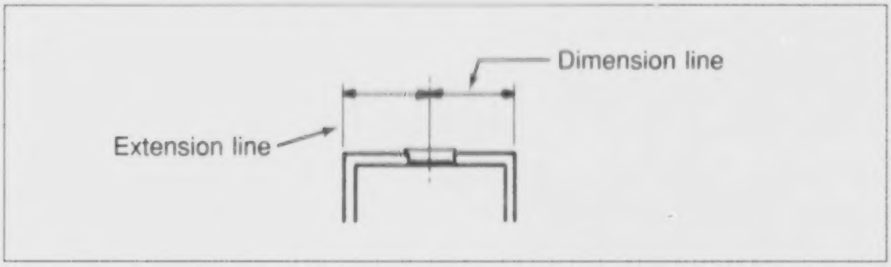
   a. **Callout**—Specific notation directed to a specific point on a drawing by a leader line

   b. **Datum line**—Established reference line from which all other dimensions are taken

   c. **Dimensioning**—Recording on working drawing the specific sizes and locations of a structure and its components

   d. **Dimension line** (Figure 1)--Line indicating dimension of a part or member

   FIGURE 1



   e. **Extension line** (see Figure 1)—Line extending from object line to dimension line

   f. **General notes**—Statements of information concerning a drawing that are normally placed together but away from the linework

2. **Statements concerning standard architectural-drafting dimensioning techniques** (see Figure 3)

   NOTE: Clear, well-placed dimensions are critical in creating a useful set of working drawings. Dimensioning that is crowded, hard to locate, incomplete, or mismatched causes a reader unnecessary delays and perhaps costly rework to a building's construction. Listed below are some of the basic guidelines drafters use when dimensioning an architectural drawing.

   a. Numerical values are shown at actual size, regardless of the scale of the drawing

   b. Extension lines are shown as thin lines that do not meet object lines and extend approximately 1/16 inch past dimension lines

INFORMATION SHEET

c. Dimension lines are shown as thin lines that are evenly spaced (minimum ⅜ inch) and unbroken from end to end

d. Dimensions are placed above dimension lines

e. Dimensions are placed so that they can be read either from the bottom or from the right side of the drawing sheet

f. Extension lines are placed so that they do not cross dimension lines; however, extension lines may cross other extension lines

g. Hidden features are not dimensioned

h. Dimensions are placed (whenever possible) with the smallest dimension closest to the object and the largest dimension furthest away

i. Dimensions larger than 12 inches are shown in feet and inches

EXAMPLES: 1′-6″, 2′-0″, 15′-11″

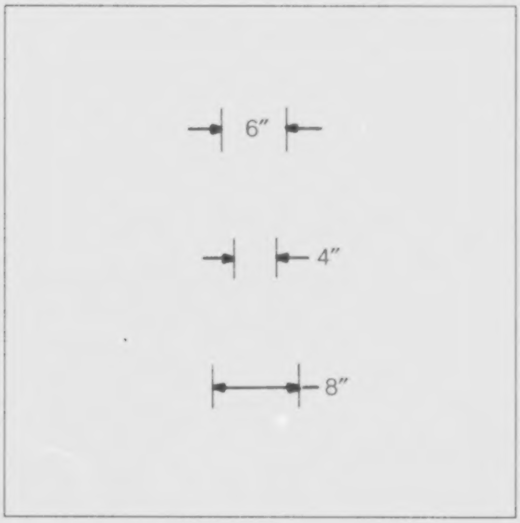
j. Dimensions less than 12 inches are shown in inches only

EXAMPLE: 4″, not 0′-4″

k. Letter height and arrowhead size are drawn consistently despite spacing

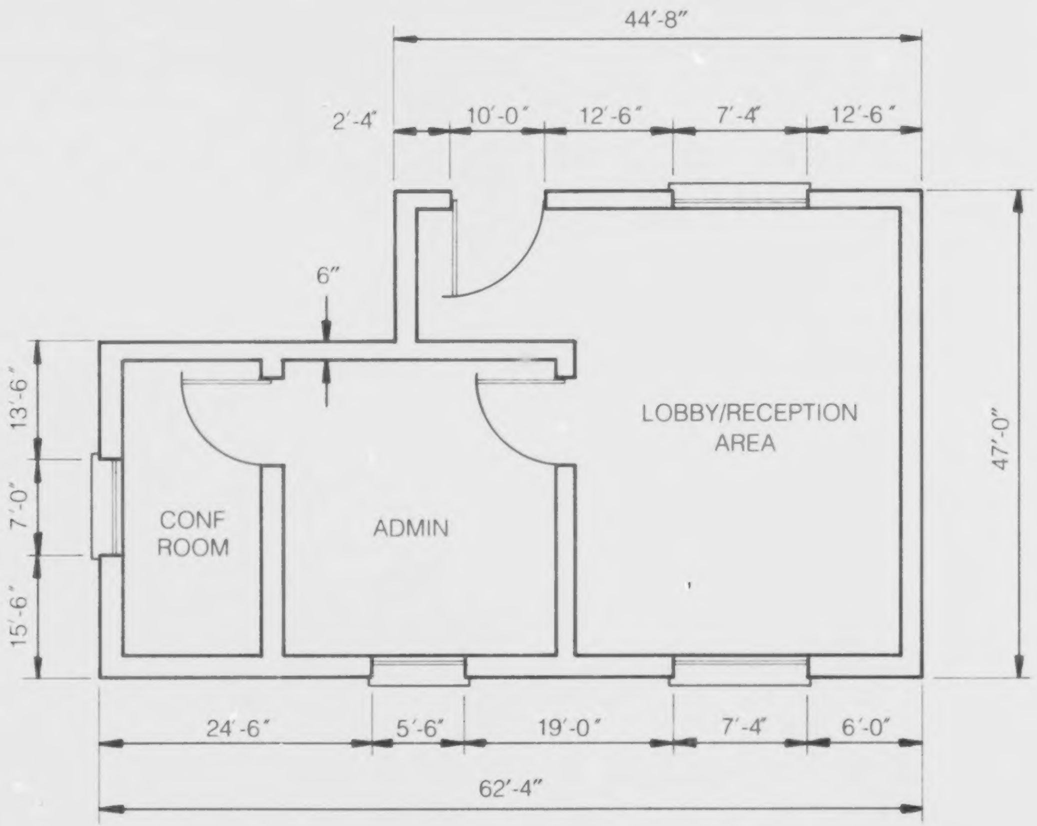
NOTE: When spacing becomes too small, the dimension and/or arrowheads are placed outside the extension lines. See Figure 2.

FIGURE 2



INFORMATION SHEET

FIGURE 3: Standard architectural-drafting dimensioning techniques


44'-8"
2'-4"
10'-0"
12'-6"
7'-4"
12'-6"
6"
13'-6"
7'-0"
15'-6"
47'-0"
LOBBY/RECEPTION AREA
CONF ROOM
ADMIN
24'-6"
5'-6"
19'-0"
7'-4"
6'-0"
62'-4"

INFORMATION SHEET

3. **Statements concerning metric-system dimensioning techniques** (see Figure 4)

   NOTE: Two measurement systems are used in the world today—the United States Customary System, using units of measure in feet, inches, etc., and the System International (SI), commonly called the *metric system*, using units of measure in meters, centimeters, millimeters, etc. With the exception of the United States, most countries use the metric system. As the United States gradually converts to the metric system, it will become more important for an architectural drafter to understand its application to drafting dimensioning. However, metric dimensioning is not yet the standard in the United States, and whenever a drafter uses metric-system dimensioning on a drawing, he or she should place a note on the drawing indicating that all dimensions are metric.

   a. Millimeters are the standard unit of measure for all working drawings except the site/plot plan, which uses meters

   b. Millimeter measurements are almost always given as whole numbers

      EXAMPLE: 340 mm

   c. Dimensions less than 1 millimeter are given in decimal form

      EXAMPLE: 47.25, not 47 ¼ .

   d. Dimensions less than 1 millimeter are indicated with a zero in front of the decimal

      EXAMPLE: 0.65 mm

   e. Four-digit dimensions are written as consecutive numbers without a comma

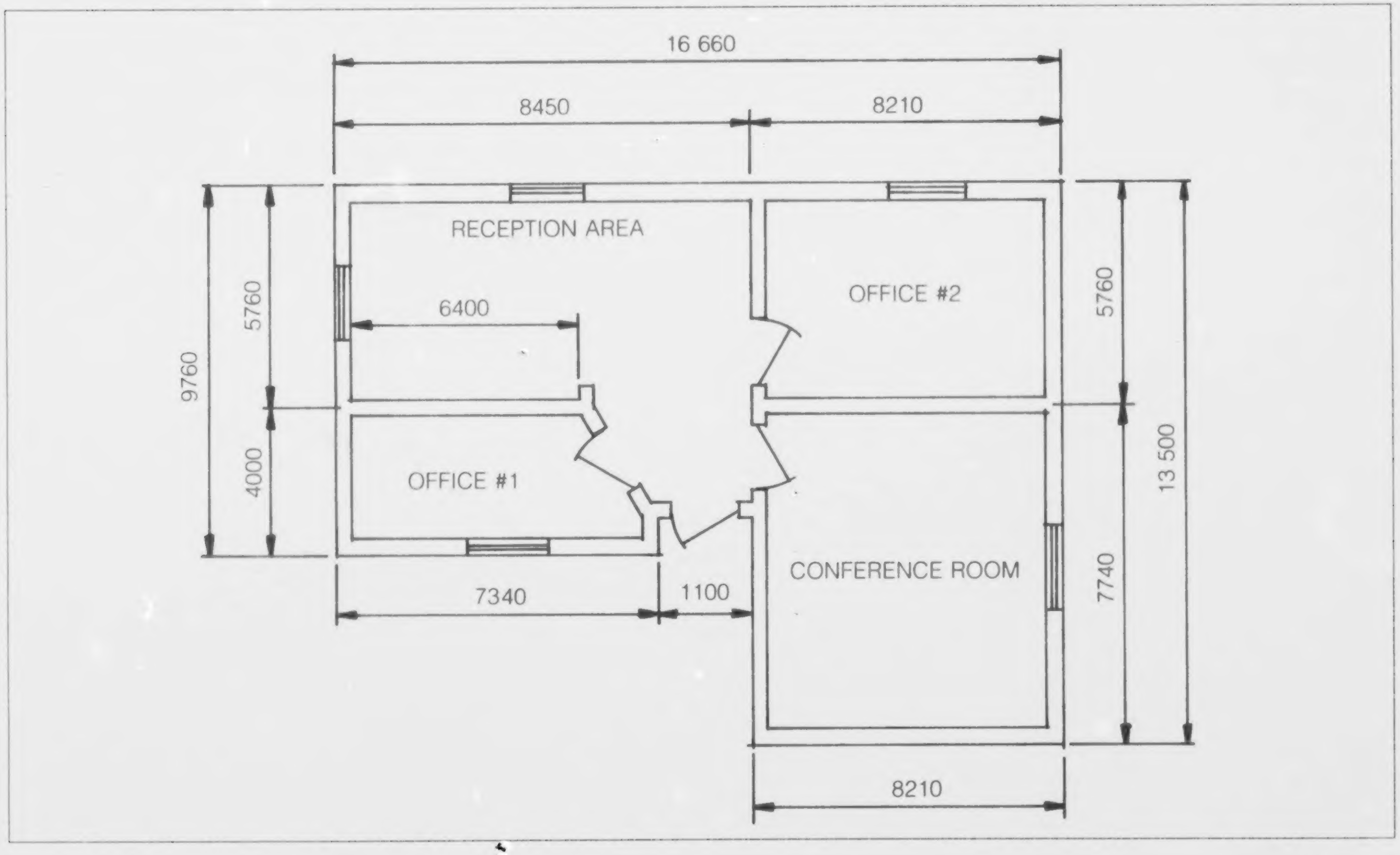
      EXAMPLE: 5300, not 5,300

   f. Dimensions of five digits or more are shown with a space—not a comma—after every third digit

      EXAMPLE: 47 500, not 47,500

INFORMATION SHEET

FIGURE 4: Metric-system dimensioning techniques


16 660
8450
8210
RECEPTION AREA
OFFICE #2
6400
5760
9760
4000
OFFICE #1
5760
13 500
7740
CONFERENCE ROOM
7340
1100
8210

INFORMATION SHEET

4. **Statements concerning modular-drafting drawing and dimensioning techniques**

NOTE: Modular drafting, where all measurements are multiples of one another (i.e., 4, 8, 12, 16, 24, etc.), is rapidly becoming a standard for construction design. The concept of using a standard design module (a 4-inch cube) allows for the most efficient use of construction materials because it minimizes material waste, and for reduced labor costs because module construction is quicker. However, modular drafting has not yet become standard, and whenever a drafter uses modular techniques, he or she should place a note on the drawing that indicates modular drafting has been used.

Modular design requires specific methods for layout and dimensioning of construction drawings. Listed below are drawing and dimensioning procedures used for modular drafting.

a. Drawings are developed on a modular grid produced in multiples of 4

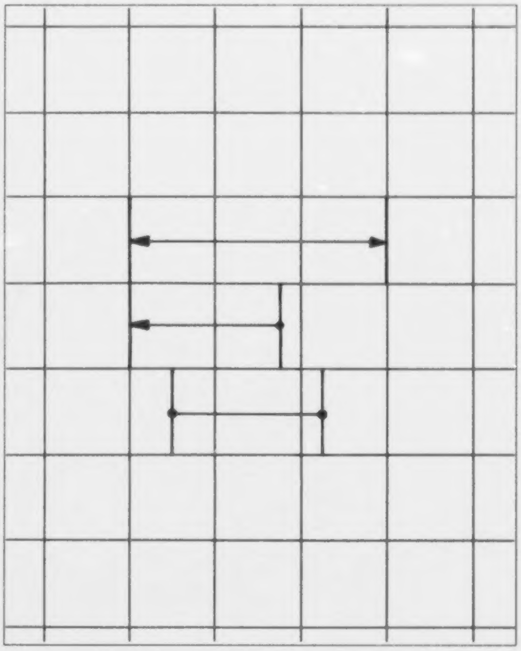
NOTE: Drawings for commercial structures are commonly drawn on a 4′-0″ grid.

b. As much as possible, building lines are drawn on grid lines

c. Arrowheads are used to indicate dimensions on the grid (see Figure 5)

d. Dots are used to indicate dimensions off the grid (Figure 5)

FIGURE 5



ARCHITECTURAL DIMENSIONING
UNIT 7

STUDENT SUPPLEMENT 1—GUIDELINES FOR DIMENSIONING FLOOR-PLAN DRAWINGS

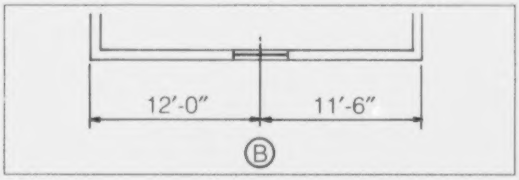
Floor-plan dimensions provide information concerning the overall building layout. An accurately dimensioned floor plan is critical to properly locating exterior walls, interior walls, doors, windows, and various other construction items.

- Place dimensions on all sides of a floor plan so as to make dimensions easy to locate.

- Show all overall and intermediate dimensions.

- Locate window and doors to their center lines, with a reference mark to a door or window. See Figure 1.

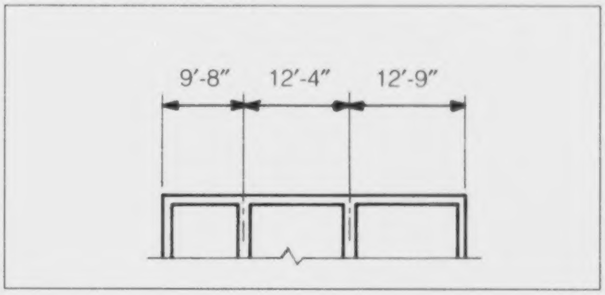
FIGURE 1



- For easy reference, identify all rooms by name or by room number.

- Dimension wall thicknesses center line to center line, or wall face to wall face, depending on the material used for the wall construction.
  - Masonry (concrete, brick, block, stone)—Dimension face of wall and wall thickness.
  - Frame (wood or veneer)—Dimension center line to center line of interior walls and to the outside of exterior walls. See Figure 2.

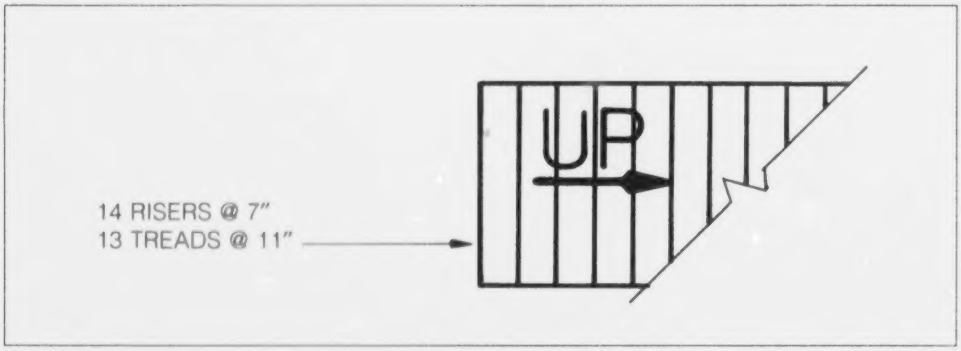
FIGURE 2



STUDENT SUPPLEMENT 1

- Label fixtures and special construction items that cannot be easily identified.
- On less complex structures, indicate the size and direction of joists and beams.
- For stairways, provide a callout indicating the number of treads and risers and their respective dimensions, as well as the stair direction (up or down). See Figure 3.

FIGURE 3



- Provide note callouts to clarify complex or unclear dimension locations or construction procedures.

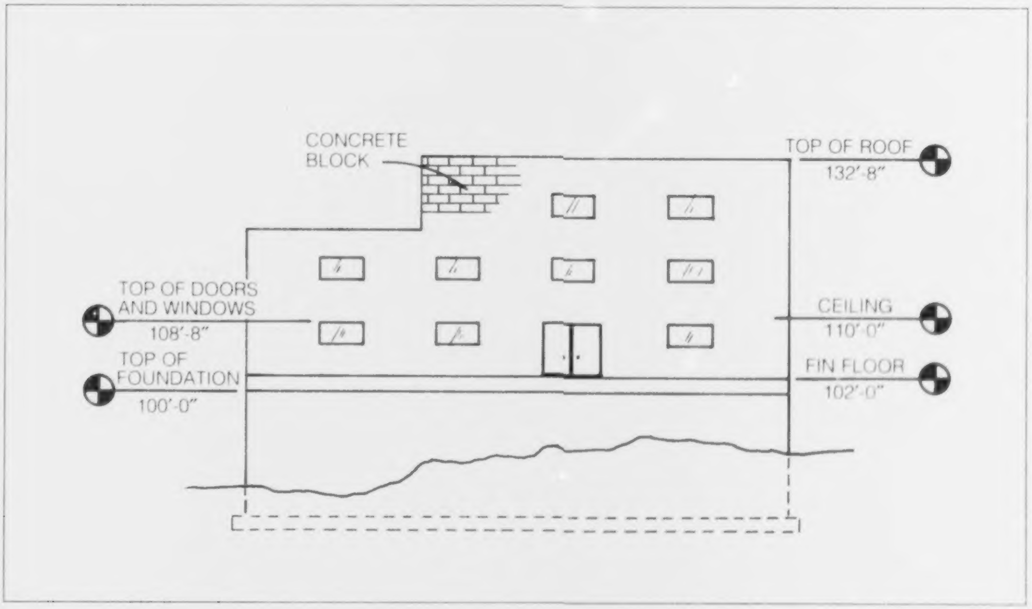
· ARCHITECTURAL DIMENSIONING
UNIT 7

STUDENT SUPPLEMENT 2—GUIDELINES FOR DIMENSIONING ELEVATION DRAWINGS

Dimensions on elevation drawings indicate vertical (height) distances of a structure. These heights are commonly dimensioned from a datum line. A datum line is an established reference line from which all dimensions are taken. On elevation drawings (see Figure 1), the finished first-floor elevation is commonly used as a datum line.

- Normally, establish a datum line to represent a reference dimension line (i.e., finished first-floor is referenced 0′-0″).
- Show dimensions to indicate finished grade, finished-floor lines, roof lines, top of doors and windows, and any other important construction feature.
- Indicate roof slope (if any).
- Indicate roof overhang (if any).
- Indicate exterior building materials with both material symbols and with a written callout.
- Indicate footings with hidden lines and dimensions in relation to an established datum line.

FIGURE 1


CONCRETE BLOCK
TOP OF ROOF
132′-8″
TOP OF DOORS AND WINDOWS
108′-8″
CEILING
110′-0″
TOP OF FOUNDATION
100′-0″
FIN FLOOR
102′-0″

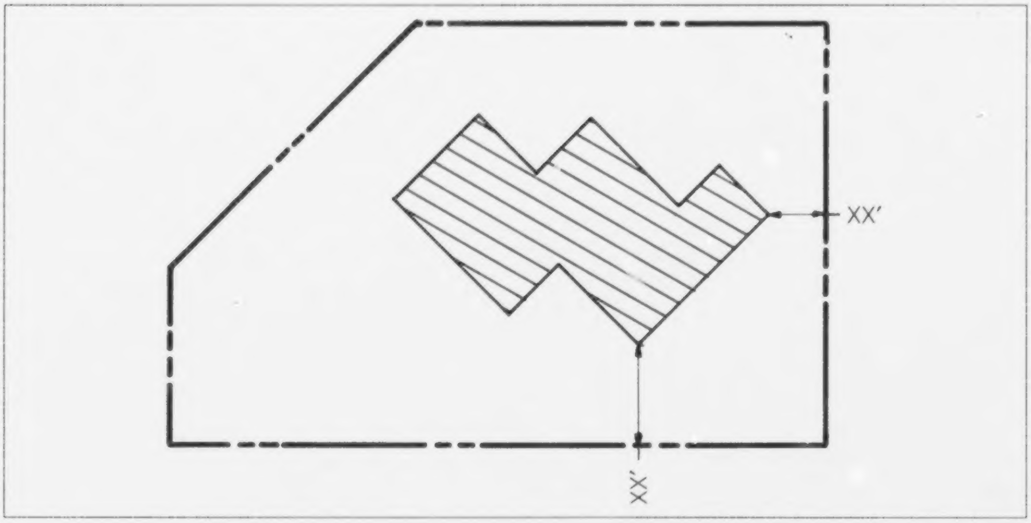
ARCHITECTURAL DIMENSIONING
UNIT 7

STUDENT SUPPLEMENT 3—GUIDELINES FOR DIMENSIONING PLOT-PLAN DRAWINGS

Plot plans (see Figure 2) are drawn to show a building's specific location on the lot upon which it is to be constructed. Plot plans also indicate the size and location of all other related construction, such as sidewalks, parking areas, utilities, etc. Proper dimensioning procedures are vital to ensure the building's correct placement and orientation on the lot.

- Locate and dimension the structure on the lot. Show and measure locating dimensions perpendicular from the lot lines to the closest corner of the structure. See Figure 1.

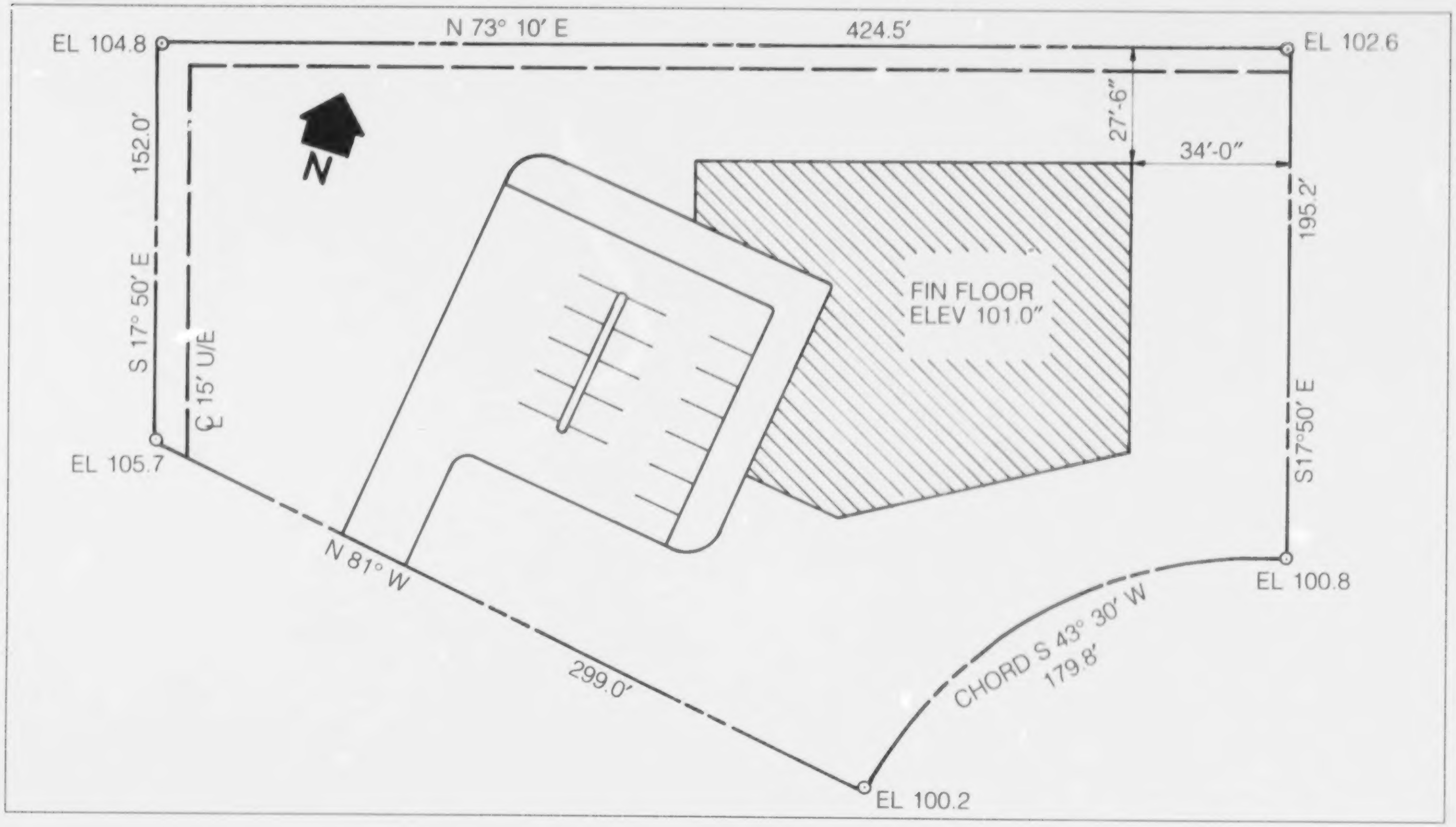
FIGURE 1



- Dimension the size and location of sidewalks, parking areas, and/or other surfaces to be constructed (i.e., landscape construction).
- Dimension and locate any utility easements on the property.
- Dimension lot size, using both bearings and distances (i.e., N47° 20′ E 189.00′).
- Indicate location of all utility lines entering the lot (i.e., electric, gas, water).
- Callout all building materials used for exterior surfaces (i.e., sidewalks, parking areas, drives, landscape construction).

STUDENT SUPPLEMENT 3

FIGURE 2


EL 104.8
N 73° 10′ E
424.5′
EL 102.6
27′-6″
34′-0″
N
152.0′
S 17° 50′ E
℄ 15′ U/E
195.2′
S17°50′ E
FIN FLOOR
ELEV 101.0″
EL 105.7
N 81° W
299.0′
CHORD S 43° 30′ W
179.8′
EL 100.8
EL 100.2

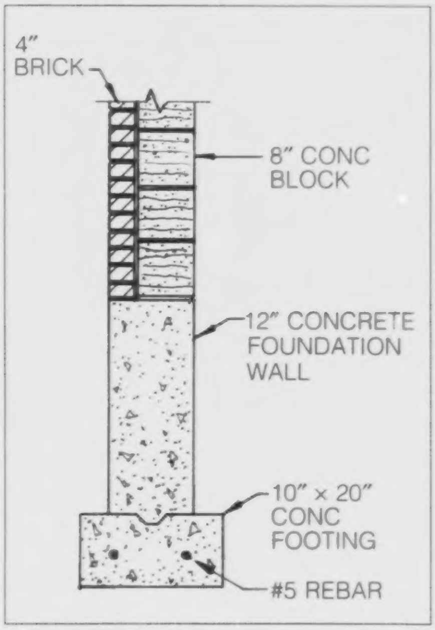
ARCHITECTURAL DIMENSIONING
UNIT 7

STUDENT SUPPLEMENT 4—GUIDELINES FOR DIMENSIONING DETAIL AND SECTION DRAWINGS

The dimensioning of detail/section drawings (see Figure 2) involves using callouts and notes that specify materials, sizes, locations, and even construction methods. Detail/section drawings should be used to define every detail of construction.

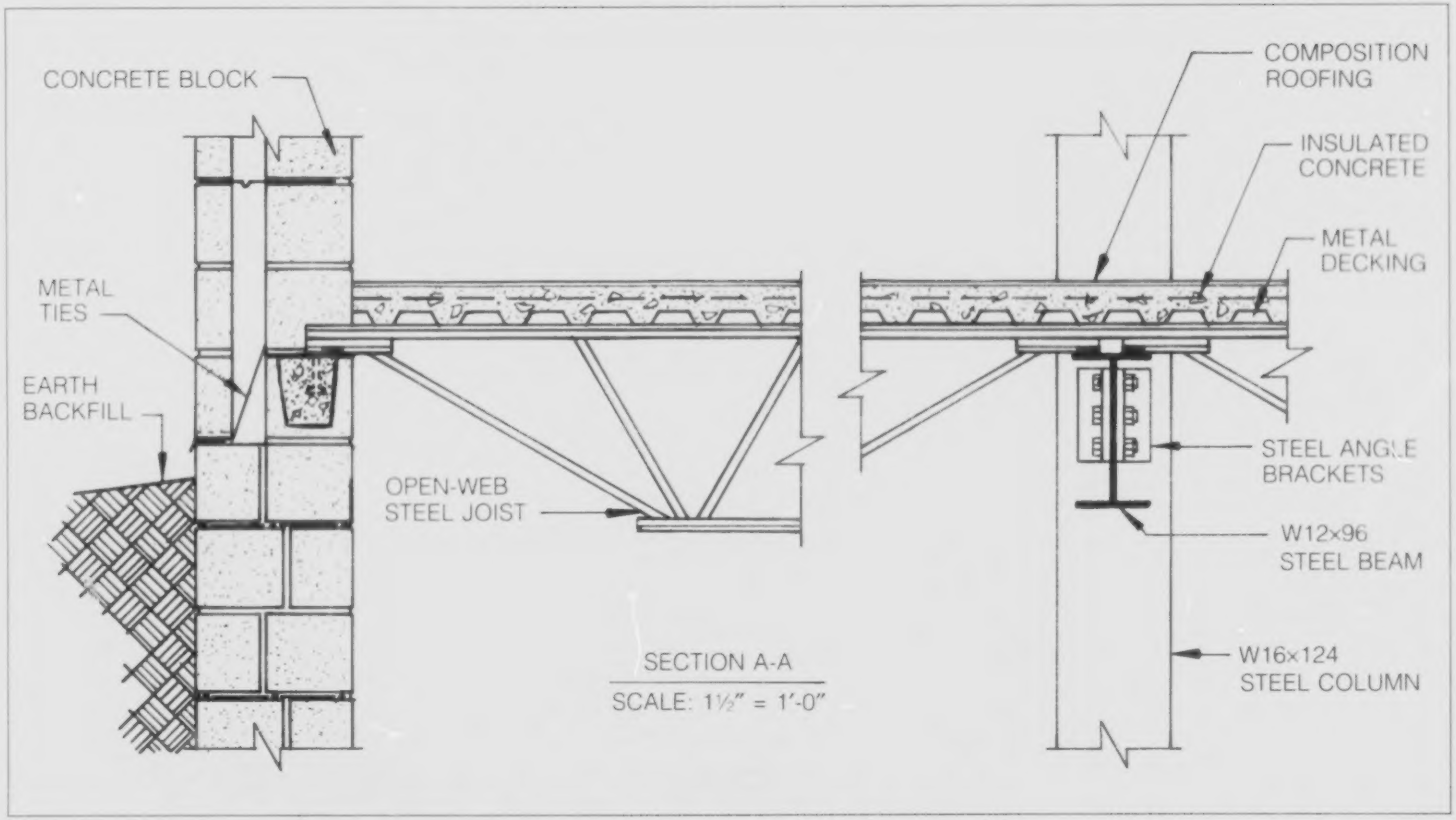
- Define all locating dimensions for construction members.
- Specify all necessary material callouts and material sizes.
- Draw materials to actual size, but note using nominal size.
- For stair details, note tread size, number of treads, size and number of risers, total stair rise, and total stair run.
- Always show the scale of a detail/section drawing below the title of the detail/section.
- Keep leader lines for callouts and notes in a straight line for reading clarity. See Figure 1.

FIGURE 1



STUDENT SUPPLEMENT 4

FIGURE 2


CONCRETE BLOCK
METAL TIES
EARTH BACKFILL
OPEN-WEB STEEL JOIST
COMPOSITION ROOFING
INSULATED CONCRETE
METAL DECKING
STEEL ANGLE BRACKETS
W12×96 STEEL BEAM
W16×124 STEEL COLUMN

SECTION A-A

SCALE: 1½" = 1'-0"

ARCHITECTURAL DIMENSIONING
UNIT 7

ASSIGNMENT SHEET 1—PRACTICE USING STANDARD ARCHITECTURAL-DRAFTING DIMENSIONING TECHNIQUES

Name ______________________ Score __________

Introduction Proper dimensioning techniques are vital to accurate, professional drawings. In this and the next five assignment sheets, you will learn to use these techniques in completing various types of working drawings.

Exercise

Directions Complete a plan view of the storage building described in the building-criteria section below. In completing this drawing, use the scale given below and follow the architectural-drafting dimensioning techniques presented in Objective 2 of the information sheet.

Scale—⅛″ = 1′-0″

Building criteria

- The storage building is to be 32′-0″ long and 23′-0″ deep.
- Four-inch-diameter columns at 8′-0″ centers will run lengthwise down the middle of the building.
- Building walls are to be 8-inch-thick concrete block.

ARCHITECTURAL DIMENSIONING
UNIT 7

ASSIGNMENT SHEET 2—DIMENSION A FLOOR PLAN

Name ______________________________ Score ______________

Exercise

Directions Study the guidelines for dimensioning a floor plan presented in Student Supplement 1 of this unit and review the standard dimensioning techniques presented in Objective 2. Then, using standard dimensioning techniques, dimension the floor plan of the fire station you completed in Unit 3, Assignment Sheet 3.

ARCHITECTURAL DIMENSIONING
UNIT 7

ASSIGNMENT SHEET 3—DIMENSION A FOUNDATION PLAN

Name ______________________________ Score ______________

Exercise

Directions Review the standard dimensioning techniques presented in Objective 2 of this unit. Then, using standard dimensioning techniques, dimension the foundation plan of the fire station you completed in Unit 6, Assignment Sheet 2.

ARCHITECTURAL DIMENSIONING
UNIT 7

ASSIGNMENT SHEET 4—DIMENSION AN ELEVATION DRAWING

Name ______________________________ Score ______________

Exercise

Directions Study the guidelines for dimensioning an elevation drawing presented in Student Supplement 2 of this unit and review the standard dimensioning techniques presented in Objective 2. Then, using standard dimensioning techniques, dimension the elevation drawing of the fire station you completed in Unit 4, Assignment Sheet 4.

ARCHITECTURAL DIMENSIONING
UNIT 7

ASSIGNMENT SHEET 5—DIMENSION A PLOT PLAN

Name ______________________________ Score ______________

Exercise

Directions Study the guidelines for dimensioning a plot plan presented in Student Supplement 3 of this unit and review the standard dimensioning techniques presented in Objective 2. Then, using standard dimensioning techniques, dimension the plot plan of the fire station you completed in Unit 3, Assignment Sheet 3.

ARCHITECTURAL DIMENSIONING
UNIT 7

ASSIGNMENT SHEET 6—DIMENSION SECTION DRAWINGS

Name ______________________________ Score ______________

Exercise

Directions Study the guidelines for dimensioning detail and section drawings presented in Student Supplement 4 of this unit and review the standard dimensioning techniques presented in Objective 2. Then, using standard dimensioning techniques, dimension the foundation sections you completed in Unit 6, Assignment Sheet 3.

ARCHITECTURAL DIMENSIONING
UNIT 7

WRITTEN TEST

Name ______________________________ Score ______________

1. Match terms associated with dimensioning to their correct definitions. Write the numbers on the blanks provided.

   ______a. Recording on working drawing the specific sizes and locations of a structure and its components

   ______b. Specific notation directed to a specific point on a drawing by a leader line

   ______c. Statements of information concerning a drawing that are normally placed together but away from the linework

   ______d. Line extending from object line to dimension line

   ______e. Line indicating dimension of a part or member

   ______f. Established reference line from which all other dimensions are taken

   1. Callout
   2. Datum line
   3. Dimensioning
   4. Dimension line
   5. Extension line
   6. General notes

2. Complete statements concerning standard architectural-drafting dimensioning techniques. Write the correct answer on the blank line(s) provided in each of the statements below.

   a. Numerical values are shown at ______________ size, regardless of the scale of the drawing.

   b. Dimension lines are shown as thin lines that are ______________ spaced and unbroken from end to end.

   c. Letter ______________ and arrowhead ______________ are drawn consistently despite spacing.

   d. Dimensions less than ______________ inches are shown in inches only.

   e. Dimensions larger than ______________ inches are shown in feet and inches.

   f. Dimensions are placed with the ______________ dimension closest to the object and the ______________ dimension furthest away.

WRITTEN TEST

g. Dimensions are placed so that they can be read either from the bottom or from the ______________ side of the drawing sheet.

h. Dimensions are placed ______________ dimension lines.

i. ______________ lines are shown as thin lines that do not meet object lines and extend approximately 1/16 inch past dimension lines.

j. Extension lines are placed so that they do not cross ______________ lines; however, extension lines may cross other extension lines.

k. ______________ features are not dimensioned.

3. Select true statements concerning metric-system dimensioning techniques. Write an "X" on the blank before each true statement in the list below.

______a. Millimeters are the standard unit of measure for all working drawings.

______b. Millimeter measurements are almost always given as whole numbers.

______c. Dimensions less than 1 millimeter are given in decimal form.

______d. Dimensions less than 1 millimeter are indicated with a zero in front of the decimal.

______e. Four-digit dimensions are written as consecutive numbers with a comma.

______f. Dimensions of five digits or more are shown with either a space or a comma after every third digit.

4. Complete statements concerning modular-drafting drawing and dimensioning techniques. Write the correct answer on the blank line(s) provided in each of the statements below.

a. Drawings are developed on a modular grid produced in multiples of ______.

b. As much as possible, ______________________ lines are drawn on grid lines.

c. ______________________ are used to indicate dimensions on the grid.

d. ______________________ are used to indicate dimensions off the grid.

PLUMBING SYSTEMS
UNIT 8

UNIT OBJECTIVE

After completing this unit, the student should be able to identify major parts of a plumbing system and complete plan and isometric plumbing drawings. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Define terms associated with plumbing systems.
2. Match major types of plumbing systems to their correct descriptions.
3. Describe the major subsystems of a plumbing system.
4. Match components of a water-distribution system to their correct definitions.
5. List characteristics of a well-designed water-distribution system for a commercial structure.
6. Match the major parts of a waste-disposal system to their correct descriptions.
7. List characteristics of a well-designed waste-disposal system for a commercial structure.
8. Identify piping symbols and abbreviations.
9. Label plan- and elevation-view plumbing-fixture symbols.
10. Define types of plans drawn for commercial plumbing systems.
11. Describe drawing methods used in completing plumbing and piping plans.
12. Distinguish among descriptions of the types of drawings done for piping and plumbing plans.
13. List factors to consider when deciding which type of drawing to use to illustrate piping and plumbing plans.
14. Calculate total fixture units per structure and determine required diameter of building sewer line for a commercial structure. (Assignment Sheet 1)
15. Use the *Uniform Plumbing Code* to answer questions about commercial plumbing systems. (Assignment Sheet 2)
16. Develop a plan drawing of a commercial plumbing system. (Assignment Sheet 3)
17. Develop an isometric drawing of a commercial plumbing system. (Assignment Sheet 4)

PLUMBING SYSTEMS
UNIT 8

SUGGESTED ACTIVITIES

Preparation

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery and Application" section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.
- Obtain media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section.
- Make transparencies from the transparency masters included in this unit.
- Prepare classroom and lab. Put up posters, charts, and signs; display articles and other references related to the objectives of this unit.

Delivery and Application

Unit introduction

- Provide students with objective sheet. Discuss unit and specific objectives.
- Show the film *Construction—Basic Principles: Plumbing.*
- Discuss with students the overall aspects of a plumbing system and the extreme importance of the proper functioning of the system (i.e., a ready supply of fresh water, waste disposal, firefighting components, etc.).
- Provide students with information sheet. Discuss information sheet.

Objective 1 Define terms associated with plumbing systems.

- Show examples that illustrate terms and make examples available to students in the classroom.

Objective 2 Match major types of plumbing systems to their correct descriptions.

- Read with the class the note introducing the objective. Then further explain the plumbing system's responsibility and the system's relationship to overall building costs.

SUGGESTED ACTIVITIES

- Discuss the advantages and disadvantages of the various types of plumbing systems listed in the objective.
- Use Figure 1 in the objective to illustrate the basic workings of a gravity system.

Objective 3 Describe the major subsystems of a plumbing system.

- Read to students the note introducing the objective and then further explain the roles the water-distribution and waste-disposal systems play in the overall function of the plumbing system.

Objective 4 Match components of a water-distribution system to their correct definitions.

- Discuss with students the definitions of the various components presented in the objective. Use Transparency 1, "Water Riser Diagram," and Figure 2 in the objective to illustrate your discussion.

Objective 5 List characteristics of a well-designed water-distribution system for a commercial structure.

- Read to students the note introducing the objective, and then further explain characteristics of a well-designed system. Also discuss the usage determinations as set forth by the *Uniform Plumbing Code* handbook.

Objective 6 Match the major parts of a waste-disposal system to their correct descriptions.

- Read to students the note introducing the objective. Then explain the responsibilities of and the terminology associated with the waste-disposal system. Use Transparency 2, "Waste Riser Diagram," to illustrate your explanation.

Objective 7 List characteristics of a well-designed waste-disposal system for a commercial structure.

- Outline the characteristics of a well-designed system and then show the film *Basic Plumbing: Installation for Drainage, Waste, and Vent Systems.*
- Discuss the usage determinations set forth in the *Uniform Plumbing Code.*
- Locate a commercial building under construction and in the construction stage where the plumbing system is being installed. Take students on a field trip to view the plumbing system. Discuss with students both the water-distribution and waste-disposal systems and identify components of each.

SUGGESTED ACTIVITIES

- Hand out Assignment Sheet 1, "Calculate Total Fixture Units per Structure and Determine Required Diameter of Building Sewer Line for a Commercial Structure," and Student Supplements 1, 2, and 3. Discuss with students the sample problem in Student Supplement 1 and demonstrate the correct use of the tables in Student Supplements 2 and 3.

- Answer any student questions and then have students complete Assignment Sheet 1.

- Hand out Assignment Sheet 2, "Use the *Uniform Plumbing Code* to Answer Questions about Commercial Plumbing Systems," and Student Supplement 4, "Guidelines for Using the *Uniform Plumbing Code.*"

- Read the student supplement to students and further explain the function of the handbook in establishing requirements for the design and installation of plumbing systems.

- Make copies of the handbook available to students in the classroom. Explain the handbook's format and divisions and have students answer sample questions by looking for information in the handbook.

- Discuss with students the exercise in Assignment Sheet 2. Answer any student questions and then have students complete Assignment Sheet 2.

Objective 8 Identify piping symbols and abbreviations.

- Discuss with the class the symbols and abbreviations listed in the objective. Use Transparency 3, "Piping Symbols," to illustrate your discussion.

- Demonstrate the correct drawing procedure for each symbol by completing drawings on the chalkboard.

- Bring samples of various pipe fittings, valves, and other plumbing components for the students to examine.

Objective 9 Label plan- and elevation-view plumbing-fixture symbols.

- Discuss with the class the symbols listed in the objective. Use Transparency 4, "Plumbing-Fixture Symbols," to illustrate your discussion.

- Demonstrate the correct drawing procedure for each symbol by completing drawings on the chalkboard. Explain the differences between representing a symbol in a plan view versus representing a symbol in an elevation view.

SUGGESTED ACTIVITIES

Objective 10 Define types of plans drawn for commercial plumbing systems.

Objective 11 Describe drawing methods used in completing plumbing and piping plans.

- Treat Objectives 10 and 11 as a unit. Read to students the note introducing Objective 10. Then explain the differences between a plumbing plan and a piping plan and the different drawing methods used to illustrate each type of plan (Objective 11).
- Show the class examples of commercial plumbing-system plans and discuss.

Objective 12 Distinguish among descriptions of the types of drawings done for piping and plumbing plans.

Objective 13 List factors to consider when deciding which type of drawing to use to illustrate piping and plumbing plans.

- Treat Objectives 12 and 13 as a unit. Read with students the information presented in the objectives. Then further discuss the options a drafter has as to how many drawings and which type of drawing he or she will use to best illustrate a particular plumbing system. Use Transparencies 5 through 9 and the figures in the objectives to illustrate your discussion.
- Hand out Student Supplement 5, "Guidelines for Completing Plumbing-System Drawings." Discuss the general guidelines for developing plumbing-system drawings that are presented in the supplement.
- Sketch both a simple plumbing and piping drawing on the chalkboard to further illustrate the process a drafter uses in presenting plumbing-system drawings.
- Hand out Assignment Sheet 3, "Develop a Plan Drawing of a Commercial Plumbing System." Discuss the assignment, answer any student questions, and have students complete Assignment Sheet 3.
- Hand out Assignment Sheet 4, "Develop an Isometric Drawing of a Commercial Plumbing System." Discuss the two-part exercise in the assignment, answer any student questions, and have students complete Assignment Sheet 4.

Evaluation

- Give written test.

SUGGESTED ACTIVITIES

- Compile written-test and assignment-sheet scores on Unit Evaluation Form.
- Reteach and retest as required.

Suggested Resources

Resources used in developing unit

Print media

- Harris, Cyril M. *Dictionary of Architecture and Construction.* New York: McGraw-Hill, 1975.
- Hettema, Robert M. *Mechanical and Electrical Building Construction.* Englewood Cliffs, New Jersey: Prentice-Hall, 1984.
- Lewis, Jack R. *Architectural Draftsman's Reference Handbook.* Englewood Cliffs, New Jersey: Prentice-Hall, 1982.
- *Uniform Plumbing Code*, 1988 ed. Walnut, California: International Association of Plumbing and Mechanical Officials, 1988.

Resources to be used as student references

NOTE: The reference listed below will be required by students in completing Assignment Sheet 2, "Use the *Uniform Plumbing Code* to Answer Questions about Commercial Plumbing Systems."

- *Uniform Plumbing Code*, 1988 ed. Walnut, California: International Association of Plumbing and Mechanical Officials, 1988.

Additional resources

Print media

- Callendar, John. *Time Saver Standards for Architectural Design Data*, 6th ed. New York: McGraw-Hill, 1982.
- Muller, Edward J. *Architectural Drawing and Light Construction.* Englewood Cliffs, New Jersey: Prentice-Hall, 1985.
- Ramsey, Charles. *Architectural Graphic Standards*, 8th ed. New York: Wiley and Sons, 1988.

SUGGESTED ACTIVITIES

Media

- *Basic Plumbing: Installation for Drainage, Waste, and Vent Systems.* No copyright date. 23 minutes. Available on VHS cassette. Bergwall Productions, P.O. Box 238, Garden City, New York 11530-0238.

  This video discusses the installation and planning procedures for developing the drainage, waste, and vent system for a typical building.

- *Construction—Basic Principles: Plumbing.* No copyright date. Order number 8703. Available on film or VHS cassette. Opportunities for Learning, 20417 Nordhoff Street, Department 1N, Chatsworth, California 91311.

  This media program explores the major subsystems, water pressure, and materials used in industrial and residential plumbing systems.

PLUMBING SYSTEMS
UNIT 8

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1	Total fixture units per structure—332 Diameter of building sewer pipe required in structure—5-inch
Assignment Sheet 2	1. Polybutylene 2. 20 gallons per minute 3. Fresh air 4. 100 5. 1½ inch 6. No
Assignment Sheet 3	Evaluated to the satisfaction of the instructor.
Assignment Sheet 4	Evaluated to the satisfaction of the instructor.

PLUMBING SYSTEMS
UNIT 8

ANSWERS TO WRITTEN TEST

1. a. Standardized pipe shape that connects piping to the plumbing system
   b. Measure of liquid flow in a plumbing system
   c. Any pipe that runs vertically to connect service branches or fixtures
   d. Vertical piping that serves as part of sewage-disposal system

2. a. 4
   b. 3
   c. 1
   d. 2

3. a. Collection of supply pipes that conduct water from water main to structure's plumbing fixtures
   b. Venting system and collection of pipes and drains that conduct solid and liquid wastes from structure to public sewer line

4. a. 1
   b. 9
   c. 2
   d. 5
   e. 6
   f. 4
   g. 3
   h. 7
   i. 8
   j. 11
   k. 10

5. Answer should include any 5 of the following

   a. A valve and meter should be located either at curb outside building or inside building, depending on local code
   b. Main water-supply line to the structure should be buried below frost line to keep supply line from freezing and rupturing
   c. Valves should be located throughout system so that various sections can be shut off without affecting water flow to rest of system
   d. Check valves, vacuum breakers, and backflow preventers are utilized to ensure that water flows in only one direction
   e. Air- or gas-filled shock absorbers are used to prevent noisy water pounding created by a rapidly closing valve
   f. Cast iron, copper, brass, and galvanized steel are used for pipes in system
   g. Heating of water is done by boilers or electric heaters, whichever is most cost effective
   h. Working water pressure and flow rates are determined by usage as set forth by the *Uniform Plumbing Code*

6. a. 3
   b. 2
   c. 9
   d. 1
   e. 8
   f. 6
   g. 7
   h. 5
   i. 4

ANSWERS TO WRITTEN TEST

7. Answer should include any 4 of the following

   a. Components are made from approved building materials
   b. Piping sizes are determined by usage set forth in the *Uniform Plumbing Code*
   c. All fixtures that contain traps are vented
   d. In multi-story structures, bathroom fixtures are located above one another; in single-story structures, bathroom fixtures are located back to back
   e. Main building drain is below grade
   f. All soil and waste stacks connect to main building drain

8. a. Elbow—turned down
   b. Cleanout
   c. Soil, waste pipe
   d. Tee—straight
   e. Meter
   f. Lateral
   g. Gas piping
   h. Elbow—90-degree
   i. Globe valve
   j. Elbow—turned up
   k. Hot-water piping
   l. Elbow—45-degree
   m. Cold-water piping
   n. Vent
   o. Tee—turned down
   p. Gate valve
   q. Tee—turned up

9. a. Lavatory
   b. Bathtub
   c. Water heater
   d. Shower stall
   e. Urinal
   f. Water closet
   g. Sink

10. a. Working drawing detailing structure's water-distribution system
    b. Working drawing detailing structure's waste-disposal system

11. a. Method of drawing that shows a two-dimensional view of given object
    b. Method of drawing that uses only one line to represent given object

12. a. ID
    b. RD
    c. PD

13. Answer should include any 2 of the following per item

    a. Plan drawing

       (1) Does not show height dimensions or slope of piping
       (2) Shows length of pipe
       (3) Shows location and type of fittings
       (4) Shows location of floor drains
       (5) Indicates direction of water flow

ANSWERS TO WRITTEN TEST

(6) Can be used to calculate labor estimates for installation and materials
(7) Provides a permanent record of pipe, fittings, and valve locations after floor has been installed or poured

b. Riser drawing

(1) Provides schematics of piping, fittings, valves, fixtures, and all other plumbing components
(2) Indicates all height dimensions and location of system components
(3) Indicates slope angle of all piping
(4) Shows vertical alignment of all plumbing fixtures
(5) Is valuable in determining spacing requirements required by local or national codes

c. Isometric drawing

(1) Combines the advantages of plan and riser drawings into one three-dimensional illustration, showing length, height, and depth of components in one drawing
(2) Shows all fittings and valves in system

PLUMBING SYSTEMS
UNIT 8

UNIT EVALUATION FORM

Student name ______________________________ Unit rating __________

Assignment sheet ratings

Assignment Sheet 1—Calculate Total Fixture Units per Structure and Determine Required Diameter of Building Sewer Line for a Commercial Structure Rating __________

Comments: ______________________________

____

Assignment Sheet 2—Use the *Uniform Plumbing Code* to Answer Questions about Commercial Plumbing Systems Rating __________

Comments: ______________________________

____

Assignment Sheet 3—Develop a Plan Drawing of a Commercial Plumbing System Rating __________

Comments: ______________________________

____

Assignment Sheet 4—Develop an Isometric Drawing of a Commercial Plumbing System Rating __________

Comments: ______________________________

____

Written test scores

Pretest __________ Other __________

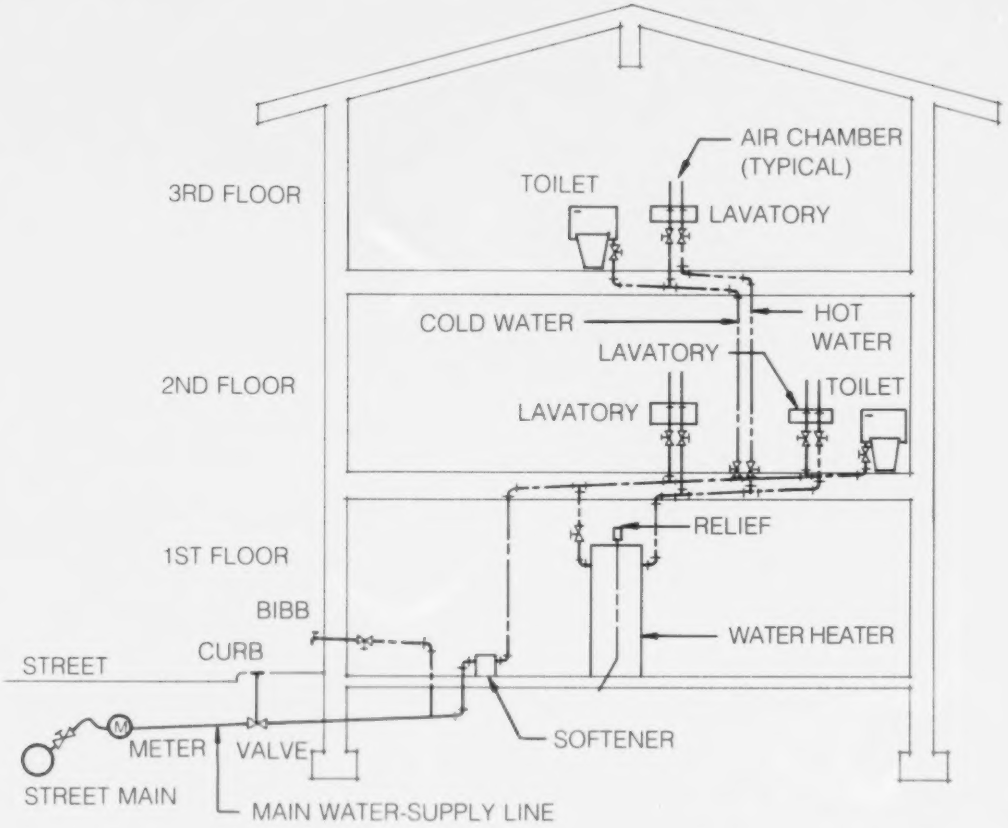
Posttest __________

Instructor signature ______________________________ Date __________

Student signature ______________________________ Date __________

Duplication of this form is permitted.

Water Riser Diagram


AIR CHAMBER
(TYPICAL)
TOILET
3RD FLOOR
LAVATORY
COLD WATER
HOT
WATER
LAVATORY
2ND FLOOR
TOILET
LAVATORY
RELIEF
1ST FLOOR
BIBB
WATER HEATER
CURB
STREET
SOFTENER
METER
VALVE
STREET MAIN
MAIN WATER-SUPPLY LINE

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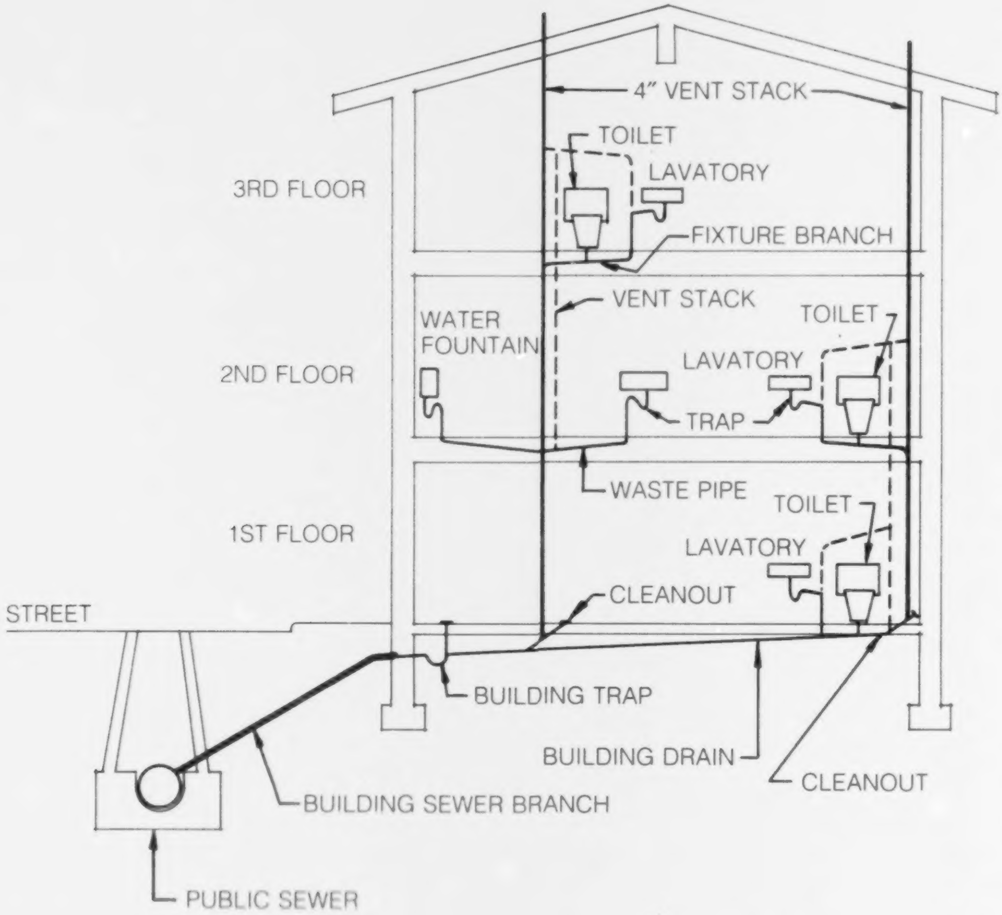
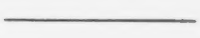
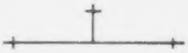
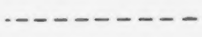
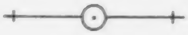
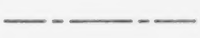
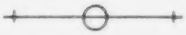
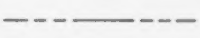
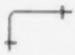
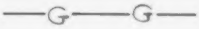
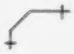
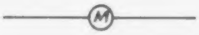
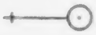
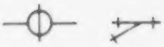
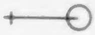
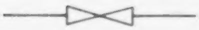
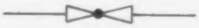
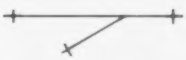
Waste Riser Diagram

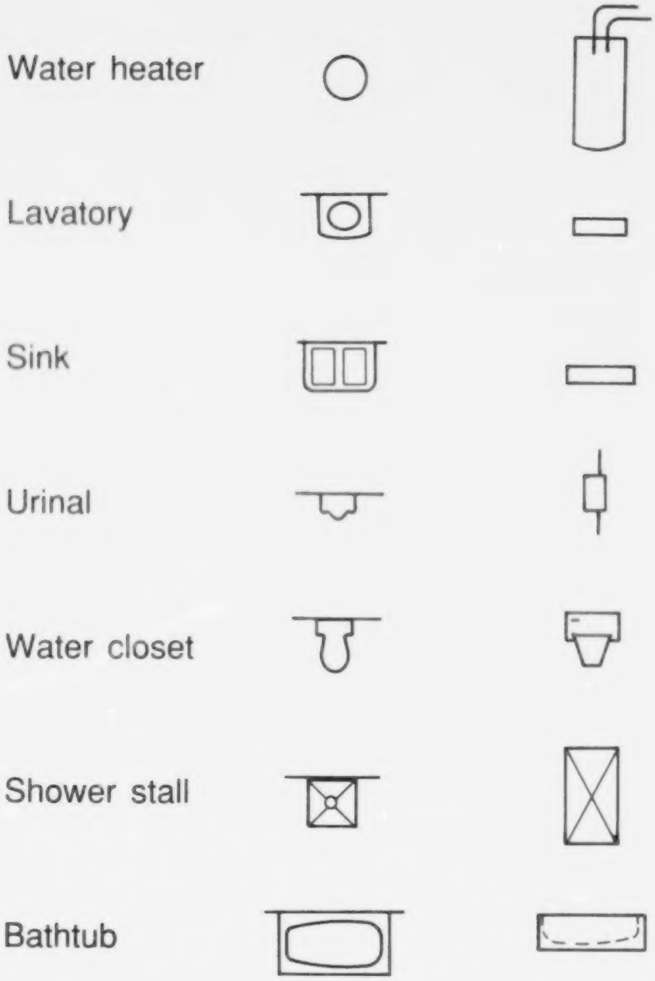

4" VENT STACK
TOILET
LAVATORY
3RD FLOOR
FIXTURE BRANCH
VENT STACK
WATER FOUNTAIN
TOILET
LAVATORY
2ND FLOOR
TRAP
WASTE PIPE
TOILET
1ST FLOOR
LAVATORY
CLEANOUT
STREET
BUILDING TRAP
BUILDING DRAIN
CLEANOUT
BUILDING SEWER BRANCH
PUBLIC SEWER

From READING ARCHITECTURAL PLANS: For Residential and Commercial Construction, 3e, © 1989, pp. 129, by Ernest R. Weidhass. Adapted with permission of Prentice-Hall, Englewood Cliffs, New Jersey.

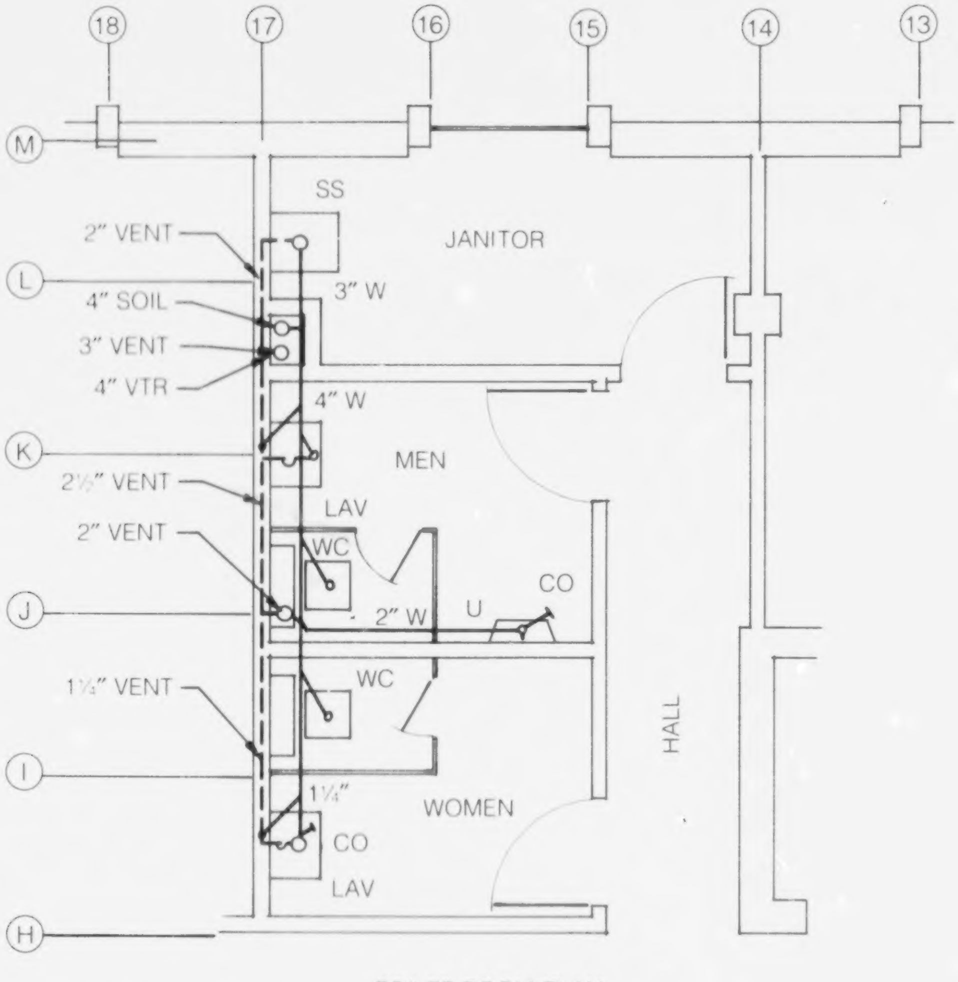
Piping Symbols

Soil, waste pipe		Tee—straight	
Vent		Tee—turned up	
Cold-water piping		Tee—turned down	
Hot-water piping		Elbow—90-degree	
Gas piping		Elbow—45-degree	
Meter		Elbow—turned up	
Cleanout		Elbow—turned down	
Gate valve		Globe valve	
Lateral			

Plumbing-Fixture Symbols


Water heater
Lavatory
Sink
Urinal
Water closet
Shower stall
Bathtub

Plan Drawing for a Commercial Plumbing System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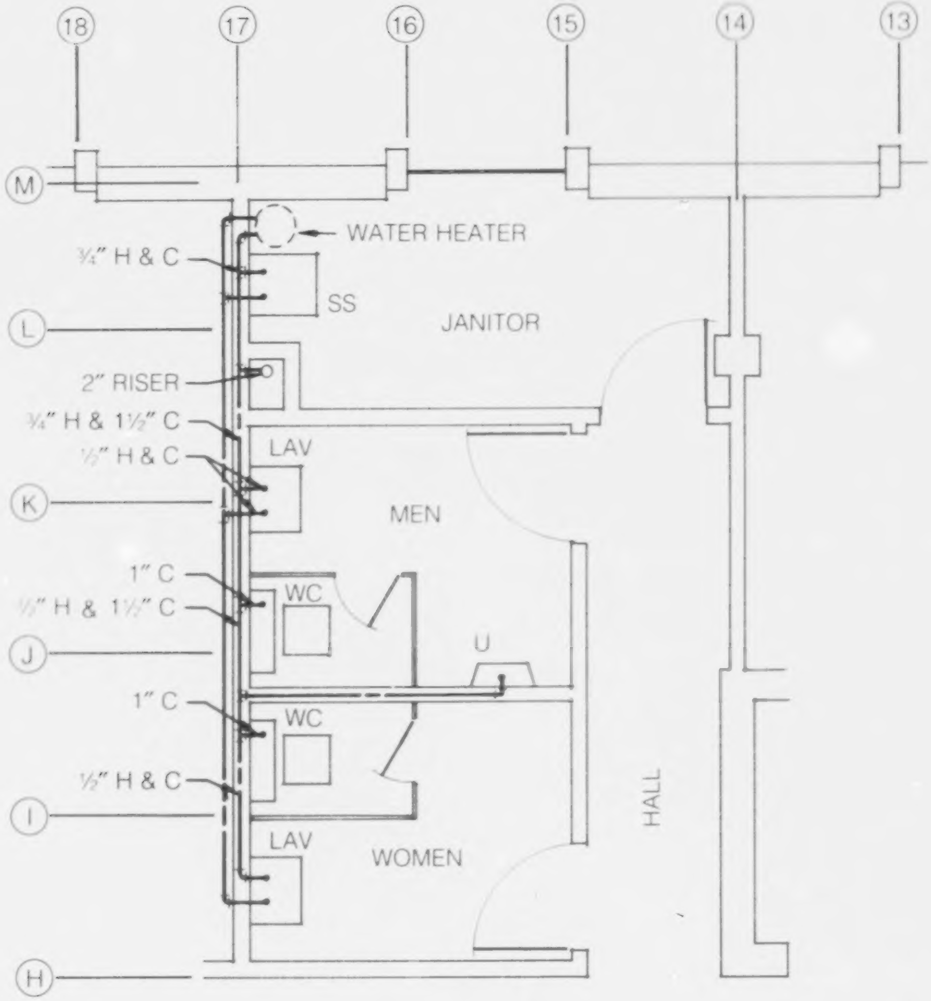
15
14
13
M
L
K
J
I
H
SS
JANITOR
2" VENT
4" SOIL
3" W
3" VENT
4" VTR
4" W
MEN
2½" VENT
LAV
2" VENT
WC
CO
2" W
U
1¼" VENT
WC
HALL
1¼"
WOMEN
CO
LAV

TOILET ROOM PLAN
(TYPICAL FOR 1ST TO 4TH FLOORS)

Courtesy of Jack W Risheberger & Associates, State College, Pennsylvania.

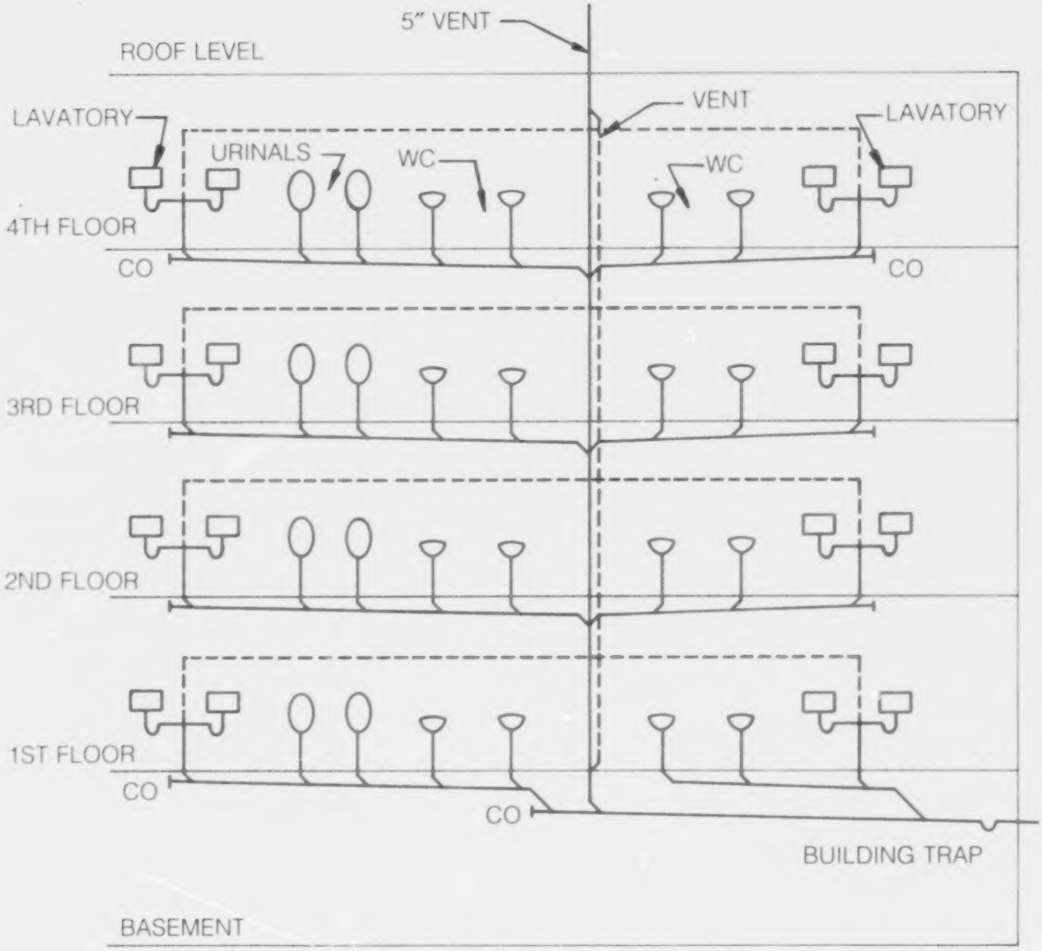
Plan Drawing for a Commercial Plumbing System
(Continued)


18
17
16
15
14
13
M
L
K
J
I
H
WATER HEATER
¾" H & C
SS
JANITOR
2" RISER
¾" H & 1½" C
½" H & C
LAV
MEN
1" C
½" H & 1½" C
WC
U
1" C
WC
½" H & C
LAV
WOMEN
HALL

TOILET ROOM PLAN
(TYPICAL FOR 1ST TO 4TH FLOORS)

Courtesy of Jack W Risheberger & Associates, State College, Pennsylvania.

Riser Drawing for a Multi-Story Commercial Building


5" VENT
ROOF LEVEL
VENT
LAVATORY
LAVATORY
URINALS
WC
WC
4TH FLOOR
CO
CO
3RD FLOOR
2ND FLOOR
1ST FLOOR
CO
CO
BUILDING TRAP
BASEMENT

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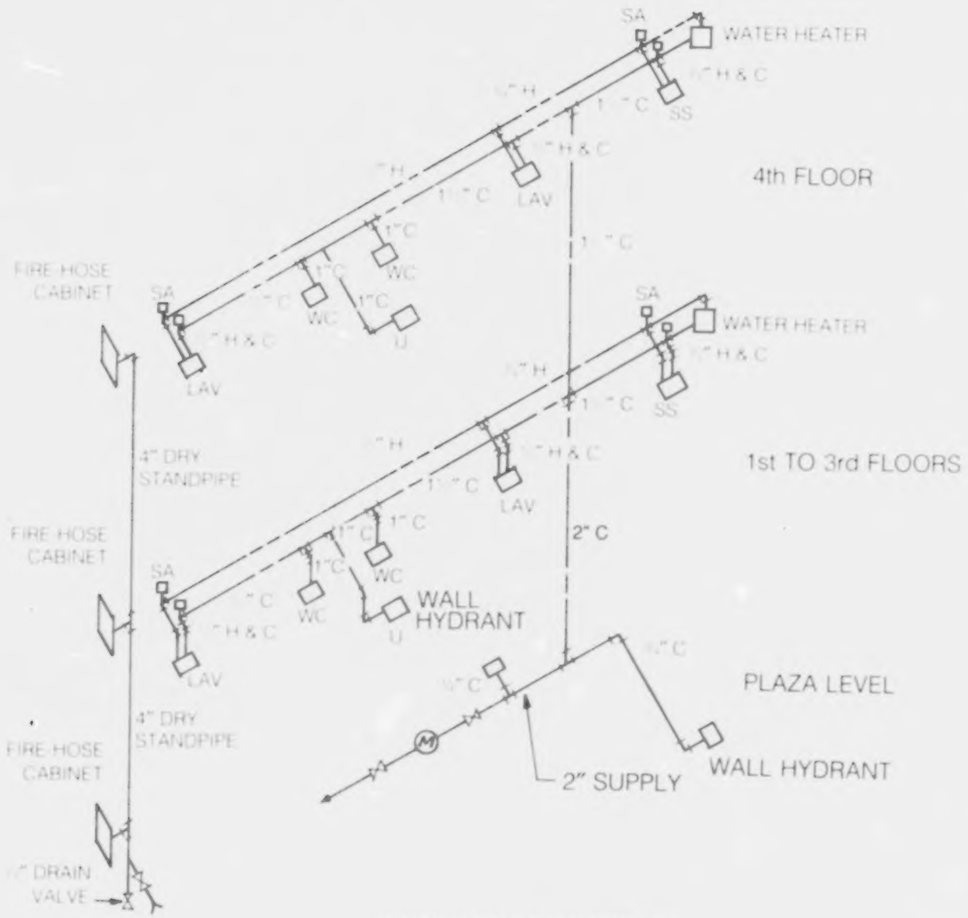
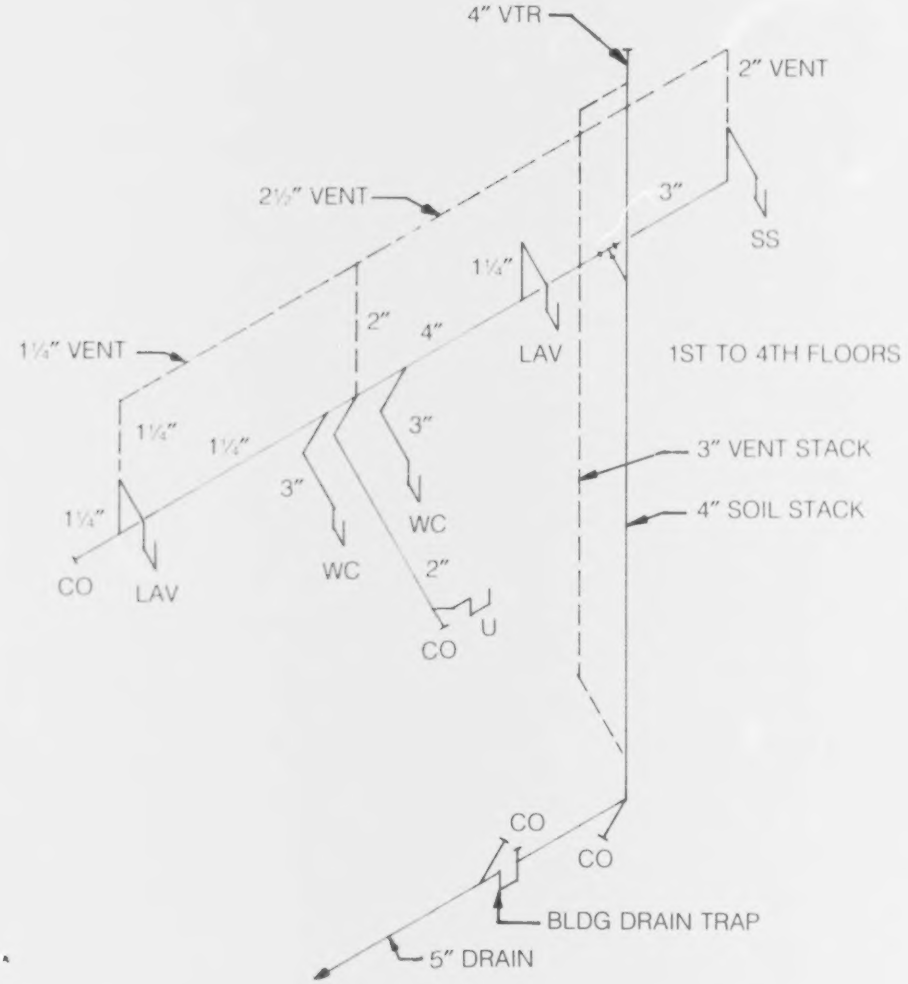
Isometric Drawing of a Commercial Plumbing System


SA
WATER HEATER
" H & C
" H
1" C
SS
" H & C
" H
1" C
LAV
4th FLOOR
1"C
1" C
FIRE-HOSE CABINET
SA
" C
1"C
WC
WC
1"C
" H & C
U
LAV
SA
WATER HEATER
" H & C
" H
1" C
SS
4" DRY STANDPIPE
" H
" H & C
1st TO 3rd FLOORS
1" C
LAV
1" C
1" C
2" C
FIRE-HOSE CABINET
SA
1"C
WC
" C
WC
WALL HYDRANT
" H & C
U
LAV
" C
PLAZA LEVEL
" C
M
4" DRY STANDPIPE
FIRE-HOSE CABINET
2" SUPPLY
WALL HYDRANT
" DRAIN VALVE

WATER-SUPPLY RISER DIAGRAM
(NO SCALE)

Courtesy of Jack W Risheberger & Associates, State College, Pennsylvania.

Isometric Drawing of a Commercial Plumbing System (Continued)


4″ VTR
2″ VENT
2½″ VENT
3″
SS
1¼″
1¼″ VENT
2″
4″
LAV
1ST TO 4TH FLOORS
1¼″
1¼″
3″
3″ VENT STACK
1¼″
3″
WC
4″ SOIL STACK
CO
LAV
WC
2″
CO
U
CO
CO
BLDG DRAIN TRAP
5″ DRAIN

WASTE RISER DIAGRAM
(NO SCALE)

Courtesy of Jack W Risheberger & Associates, State College, Pennsylvania.

PLUMBING SYSTEMS
UNIT 8

INFORMATION SHEET

1. **Terms and definitions associated with plumbing systems**

   a. **Fitting**—Standardized pipe shape that connects piping to the plumbing system

   EXAMPLES: Elbow, tee, bend, reducer

   b. **Fixture unit**—Measure of liquid flow in a plumbing system

   NOTE: One fixture unit equals 1 cubic foot of liquid per minute. There are 7½ gallons in 1 cubic foot.

   c. **Riser**—Any pipe that runs vertically to connect service branches or fixtures

   d. **Stack**—Vertical piping that serves as part of sewage-disposal system

   EXAMPLES: Vent stacks, waste stacks, soils stacks

2. **Major types of plumbing systems and their descriptions**

   NOTE: In commercial construction, a properly designed and built plumbing system is one of the most important aspects of the entire construction project. Although the plumbing system represents a small portion of the overall building cost (6 percent on average), the system is responsible for providing the building's drinking water and fire-prevention system as well as for keeping the building clean and sanitary.

   To satisfy different types of plumbing needs, a number of system types have been developed. The major types of systems are described below.

   a. **Hydropneumatic system** (compressed-air system)—System in which a pump operates to keep a sealed tank filled with water to compress air trapped in tank at a desired pressure

   NOTE: The advantage of a hydropneumatic system is that it can be sized for either large or small construction projects.

   b. **Gravity system** (see Figure 1)—System in which pumps placed in basement of building pump water into tanks placed at top of building and pressure is created when water flows downward by the force of gravity

   NOTE: The advantages of a gravity system are that it allows continuous water pressure even in the event of power failures and ensures water availability for firefighting at all times.

   c. **Direct system**—System in which water pumps are placed at lower and upper ends of building to provide water throughout structure at calculated quantities and pressure

   NOTE: An advantage of the direct system is that the life of the water pumps involved can be extended by running the pumps alternately. A disadvantage of the system is that a loss of water pressure could easily occur from an electrical power failure.

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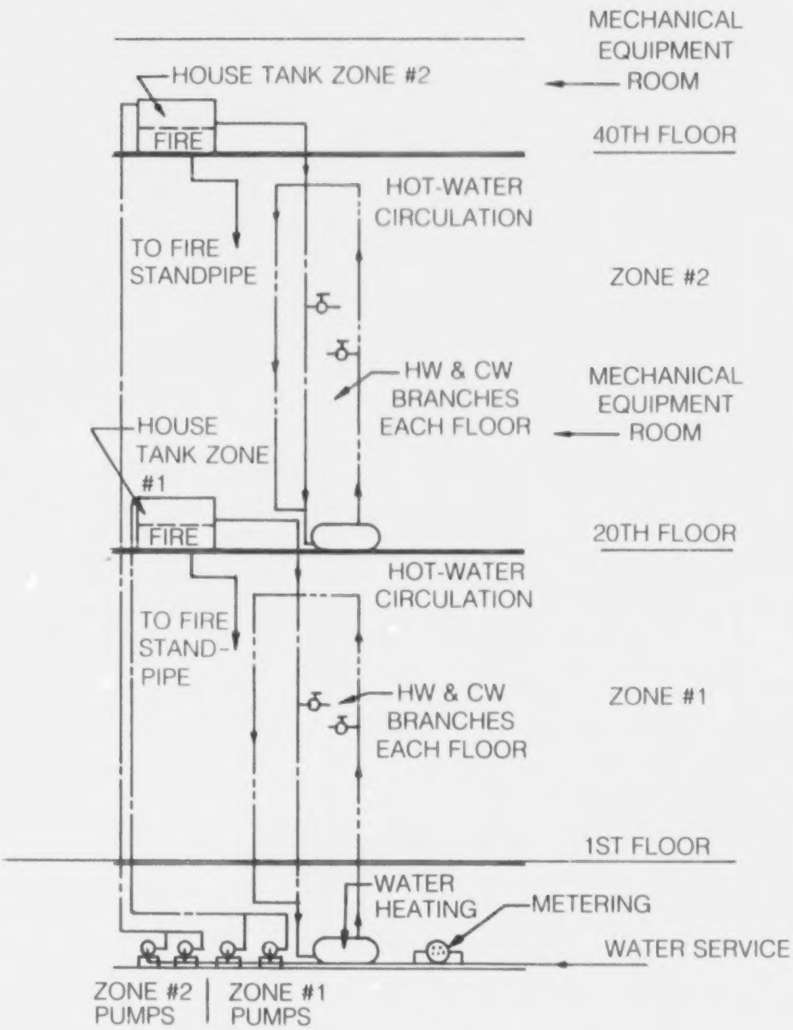
d. **Gas-piping system**—System in which pipes and valves or fittings are used to conduct natural or manufactured gas to fuel-burning plumbing fixtures (water heaters, steam boilers, gas engines for pumps, Bunsen burners, etc.)

FIGURE 1: Gravity water system for domestic and firefighting supply


MECHANICAL EQUIPMENT ROOM
HOUSE TANK ZONE #2
FIRE
40TH FLOOR
HOT-WATER CIRCULATION
TO FIRE STANDPIPE
ZONE #2
HW & CW BRANCHES EACH FLOOR
MECHANICAL EQUIPMENT ROOM
HOUSE TANK ZONE #1
FIRE
20TH FLOOR
HOT-WATER CIRCULATION
TO FIRE STAND-PIPE
ZONE #1
HW & CW BRANCHES EACH FLOOR
1ST FLOOR
WATER HEATING
METERING
WATER SERVICE
ZONE #2 PUMPS
ZONE #1 PUMPS

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3. **Major subsystems of a plumbing system and their descriptions**

   NOTE: Any plumbing system, whether a simple residential system or a complex commercial system, contains two major subsystems—the water-distribution system and the waste-disposal system. These two types of systems are described below.

   a. **Water-distribution system**—Collection of supply pipes that conduct water from water main to structure's plumbing fixtures

   b. **Waste-disposal system** (drainage, waste, and vent [DWV] system)—Venting system and collection of pipes and drains that conduct solid and liquid wastes from structure to public sewer line

4. **Components of a water-distribution system and their definitions** (see Figure 2)

   NOTE: As the carrier for fresh water, the water-distribution system provides both hot and cold water to all areas of a structure.

   a. **Main water-supply line**—Main supply pipe used to convey water into structure from community water system (street main)

   b. **Water meter**—Device used to measure volume of water passing through main water-supply line at entrance to structure

   c. **Valves**—Control devices for regulating flow of water

      NOTE: Several types of valves are used in a water-distribution system. Check valves, for example, allow the flow of water in one direction only, preventing the backflow of water. Relief valves are valves activated to open when pressure and/or temperature in a system exceeds safe operating limits, and then are activated to close when pressure and/or temperature returns to safe levels.

   d. **Backflow preventers**—Plumbing devices that stop the flow of water in the direction opposite its normal flow

      EXAMPLE: Vacuum breaker—backflow preventer installed in system to prevent a vacuum from causing backflow

   e. **Cold-water pipes**—Piping for transporting cold water from one location to another within structure

   f. **Hot-water pipes**—Piping for transporting hot water from water heater to other locations within structure

   g. **Water heater**—Appliance used to heat water

   h. **Bibbs**—Faucets or taps threaded so a hose may be attached to carry water

   i. **Air chambers**—Short sections of supply pipe that extend beyond last fitting on line; used to prevent water hammer

      NOTE: Water hammer is a loud noise created when a faucet is shut off.

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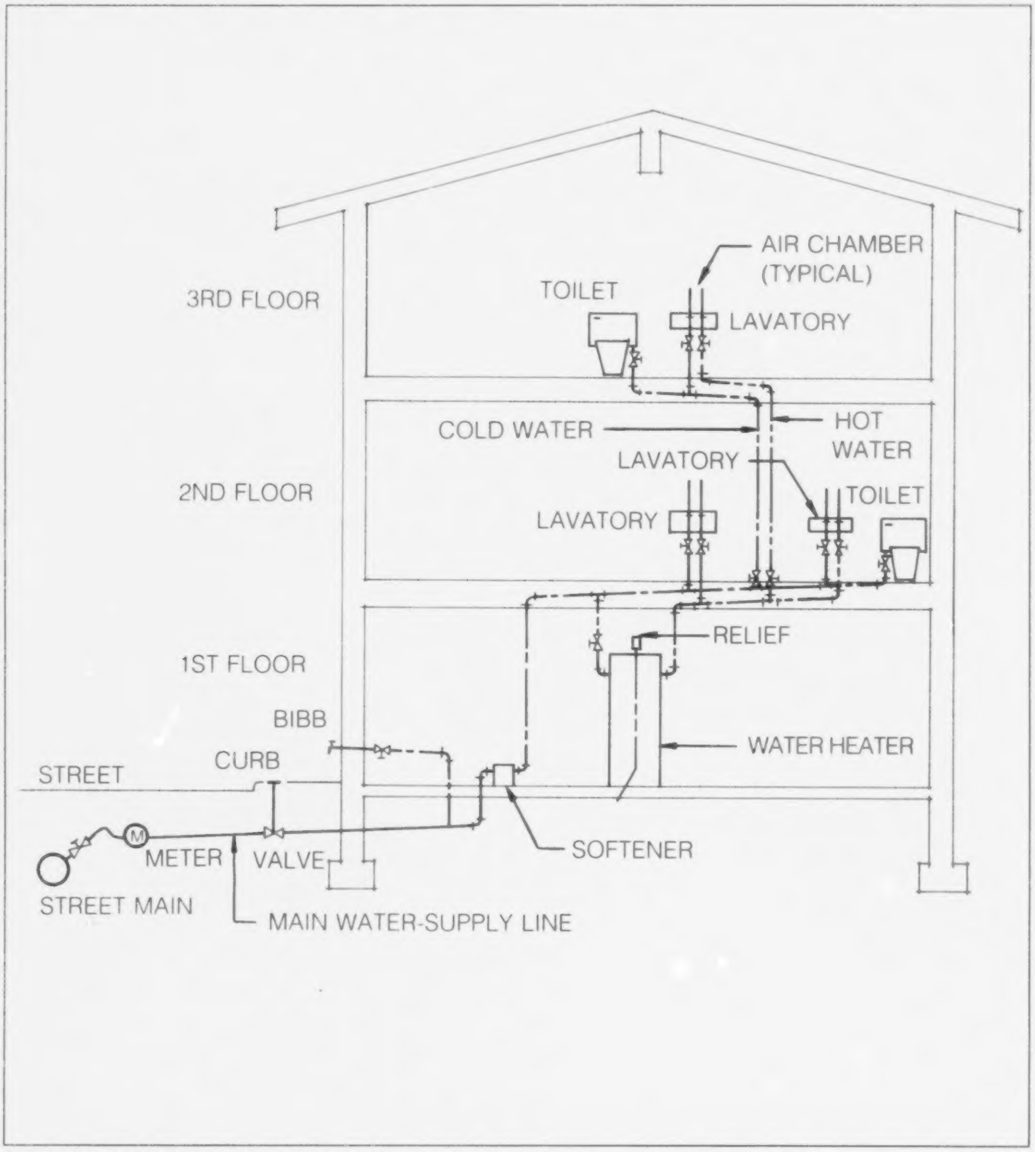
j. **Drain softener**—Filtering system designed to remove sediment deposits from the main water supply

k. **Shock absorbers**—Devices in piping system used to reduce shock that occurs when water flow is suddenly obstructed

FIGURE 2: Water riser diagram


AIR CHAMBER (TYPICAL)
3RD FLOOR
TOILET
LAVATORY
COLD WATER
HOT WATER
LAVATORY
2ND FLOOR
LAVATORY
TOILET
RELIEF
1ST FLOOR
BIBB
CURB
STREET
WATER HEATER
M
METER
VALVE
SOFTENER
STREET MAIN
MAIN WATER-SUPPLY LINE

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5. **Characteristics of a well-designed water-distribution system for a commercial structure**

NOTE: A well-designed water-distribution system for a commercial structure will account for proper water-pressure regulation, ease of maintenance, minimal noise, and a continual, adequate water supply.

a. A valve and meter should be located either at curb outside building or inside building, depending on local code

NOTE: The valve and meter will monitor water flow into the structure and allow the water supply to be shut off if necessary.

b. Main water-supply line to the structure should be buried below frost line to keep supply line from freezing and rupturing

c. Valves should be located throughout system so that various sections can be shut off without affecting water flow to rest of system

d. Check valves, vacuum breakers, and backflow preventers are utilized to ensure that water flows in only one direction

e. Air- or gas-filled shock absorbers are used to prevent noisy water pounding (water hammer) created by a rapidly closing valve

f. Cast iron, copper, brass, and galvanized steel are used for pipes in system

NOTE: Cast-iron, copper, brass, or galvanized steel pipes are required for water-supply lines in commercial buildings. Most codes prohibit the use of plastic piping in this type of system.

g. Heating of water is done by boilers or electric heaters, whichever is most cost effective

h. Working water pressure and flow rates are determined by usage as set forth by the *Uniform Plumbing Code*

6. **Major parts of a waste-disposal system and their descriptions** (Figure 3)

NOTE: The waste-disposal system in a commercial building receives a great deal of attention in the design and installation stages of construction because of its complexity and function within the structure. The system includes all disposal lines carrying human, industrial, washing, and kitchen wastes as well as the venting system that ensures the entire system functions properly.

a. **Vent stacks**—Vertical pipes extending above building to allow air flow into waste piping

NOTE: The air flow provided by the vent stacks prevents a siphoning action by the waste water that would cause the water in the system's water traps to empty.

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b. **Soil stacks**—Large vertical pipes that accept solid wastes from water closets and conducts it to building drain

c. **Waste stacks**—Large vertical pipes that accept liquid waste from fixtures not receiving solid waste (sinks, water fountains, lavatories) and discharges it into soil pipe or building drain

d. **Building drain**—Drain that receives discharge from soil and waste pipes and carries it to building sewer branch

e. **Building sewer branch**—Large pipe that carries discharge from soil and waste pipes from building drain to public sewer

f. **Fixtures**—Pieces of equipment attached to plumbing piping system

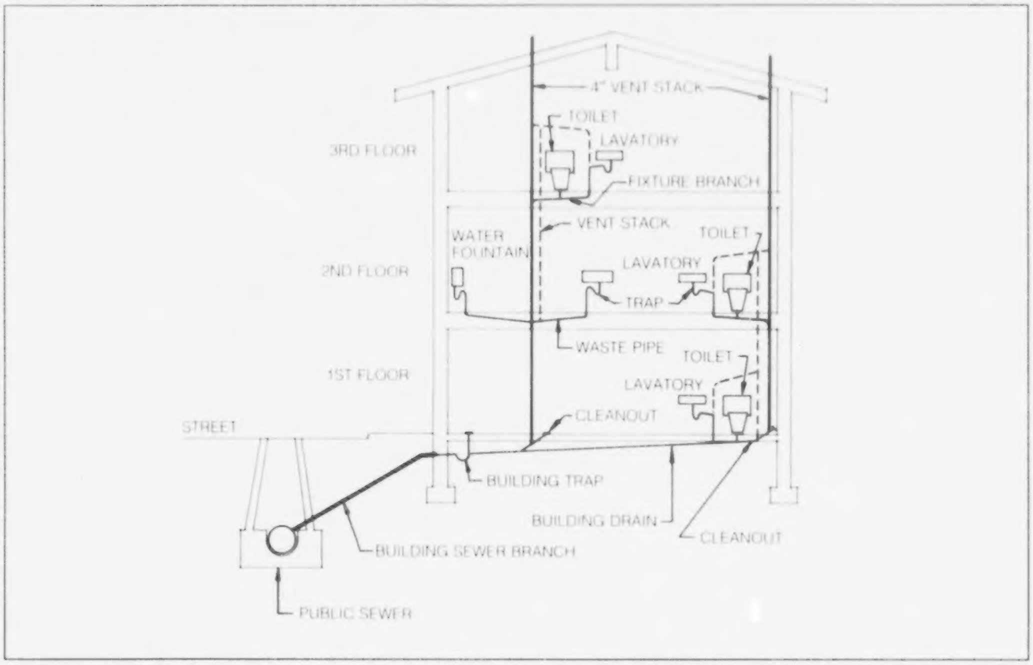
EXAMPLES: Lavatories, toilets (water closets), sprinkler systems, drinking fountains, etc.

g. **Fixture branches**—Slightly pitched horizontal pipes that carry waste water to main vertical waste stacks

h. **Traps**—U-shaped fittings located near each fixture; retain water to act as a seal to prevent gases from backing up through fixture and into structure

i. **Cleanouts**—Pipe fittings with removable plug placed at end of horizontal piping runs to allow access to waste-disposal system for cleaning and inspection

FIGURE 3: Waste riser diagram


4" VENT STACK
TOILET
LAVATORY
3RD FLOOR
FIXTURE BRANCH
VENT STACK
TOILET
WATER FOUNTAIN
2ND FLOOR
LAVATORY
TRAP
WASTE PIPE
TOILET
1ST FLOOR
LAVATORY
CLEANOUT
STREET
BUILDING TRAP
BUILDING DRAIN
CLEANOUT
BUILDING SEWER BRANCH
PUBLIC SEWER

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7. **Characteristics of a well-designed waste-disposal system for a commercial structure**

   a. Components are made from approved building materials

      EXAMPLES: Brass, galvanized wrought iron, cast iron, copper pipe, ABS plastic pipe, PVC plastic pipe

   b. Piping sizes are determined by usage set forth in the *Uniform Plumbing Code*

   c. All fixtures that contain traps are vented

   d. In multi-story structures, bathroom fixtures are located above one another; in single-story structures, bathroom fixtures are located back to back

      NOTE: Locating fixtures as described above preserves space and decreases the cost of the system.

   e. Main building drain is below grade

   f. All soil and waste stacks connect to main building drain

8. **Piping symbols and abbreviations** (Table 1)

   NOTE: Listed below are the most commonly used symbols and abbreviations used in the development of plumbing and piping drawings.

TABLE 1

Component name	Symbol	Component abbreviation
Soil, waste pipe	————————	SW
Vent	- - - - - - - - - -	V
Cold-water piping	—— - —— - - ——	CW
Hot-water piping	- - - ——— - - -	HW
Gas piping	—— G —— G ——	G
Meter	——— Ⓜ ———	—

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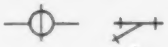
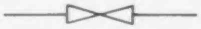
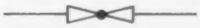
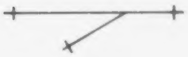
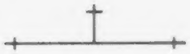
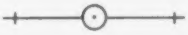
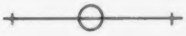
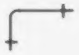
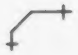
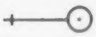
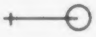
TABLE 1 (cont.)

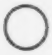
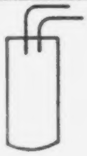
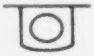
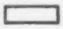
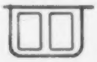
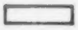
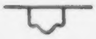
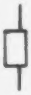
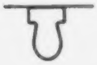
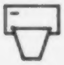
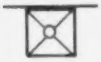
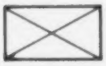
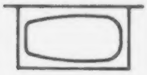
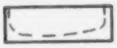
Component name	Symbol	Component abbreviation
Cleanout		CO
Gate valve		—
Globe valve		—
Lateral		—
Tee—straight		—
Tee—turned up		—
Tee—turned down		—
Elbow—90-degree		—
Elbow—45-degree		—
Elbow—turned up		—
Elbow—turned down		—

INFORMATION SHEET

9. Plan- and elevation-view plumbing-fixture symbols (Table 2)

NOTE: Listed below are the plumbing-fixture symbols most commonly seen on plumbing drawings.

TABLE 2

Component name	Plan-view symbol	Elevation-view symbol
Water heater (hot-water tank)		
Lavatory		
Sink		
Urinal		
Water closet		
Shower stall		
Bathtub		

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10. Types of plans drawn for commercial plumbing systems and their definitions

NOTE: Because the plumbing systems of commercial structures are usually large and complex, the water-distribution and waste-disposal systems are drawn separately. Descriptions of the plan drawings done for these two systems follow.

a. **Piping plan**—Working drawing detailing structure's water-distribution system

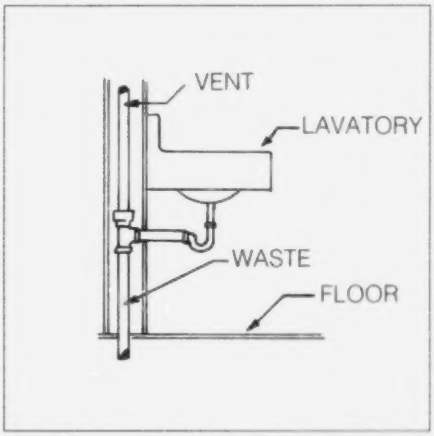
b. **Plumbing plan**—Working drawing detailing structure's waste-disposal system

INFORMATION SHEET

11. Drawing methods used in completing plumbing and piping plans and their descriptions

a. **Double-line method** (Figure 4)—Method of drawing that shows a two-dimensional view of given object

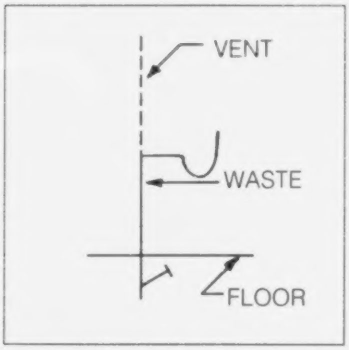
FIGURE 4: Lavatory detail



b. **Single-line method** (schematic drawing method) (Figure 5)—Method of drawing that uses only one line to represent given object

NOTE: The single-line method is commonly used in developing plumbing plans. Schematic drawings are not drawn to scale.

FIGURE 5: Schematic

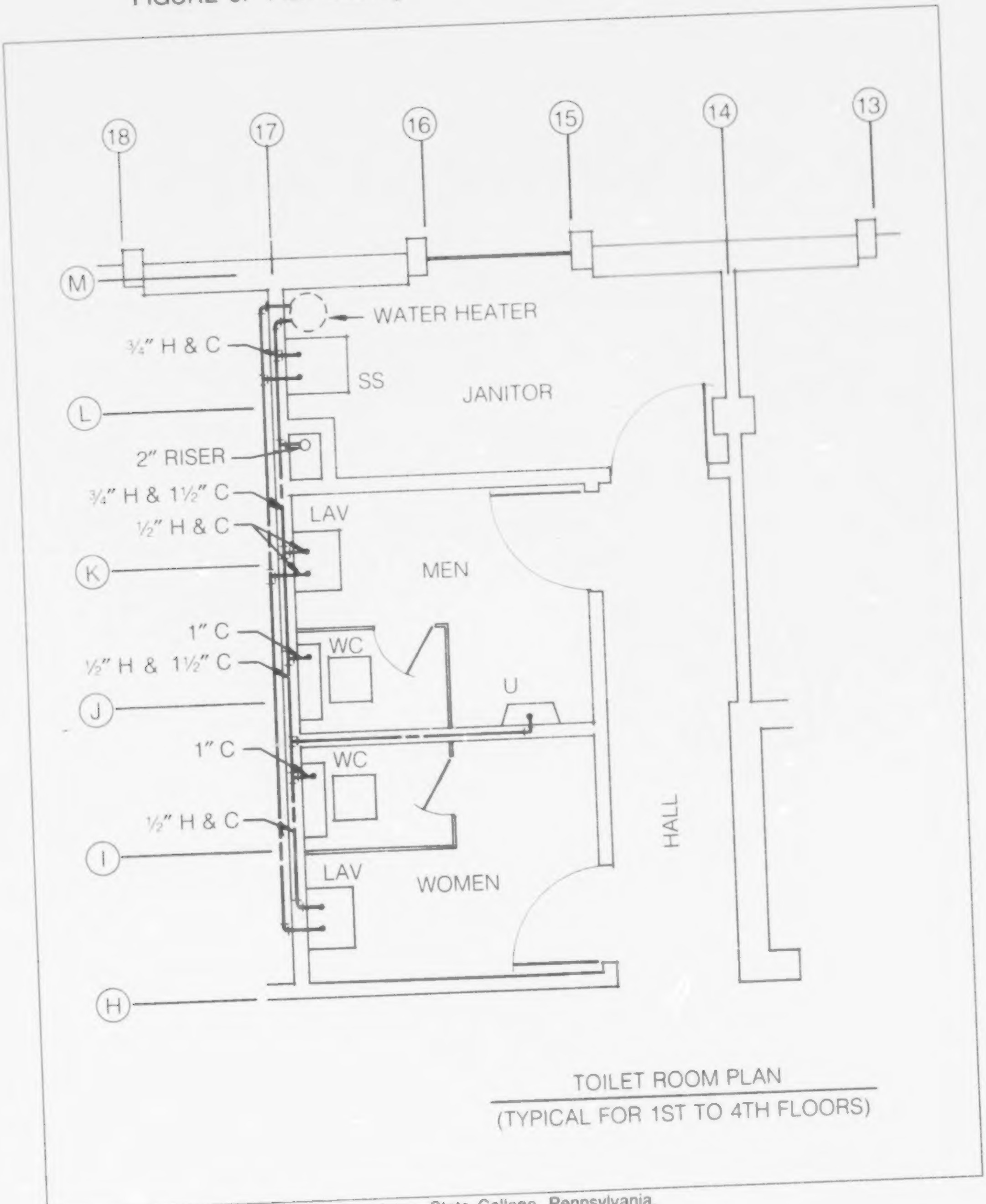


12. Types of drawings done for piping and plumbing plans and their descriptions

a. **Plan drawing** (see Figure 6)—Plan-view drawing showing the plumbing or piping plan as viewed from directly above—the same view as shown on a floor-plan drawing

INFORMATION SHEET

FIGURE 6: Plan drawing

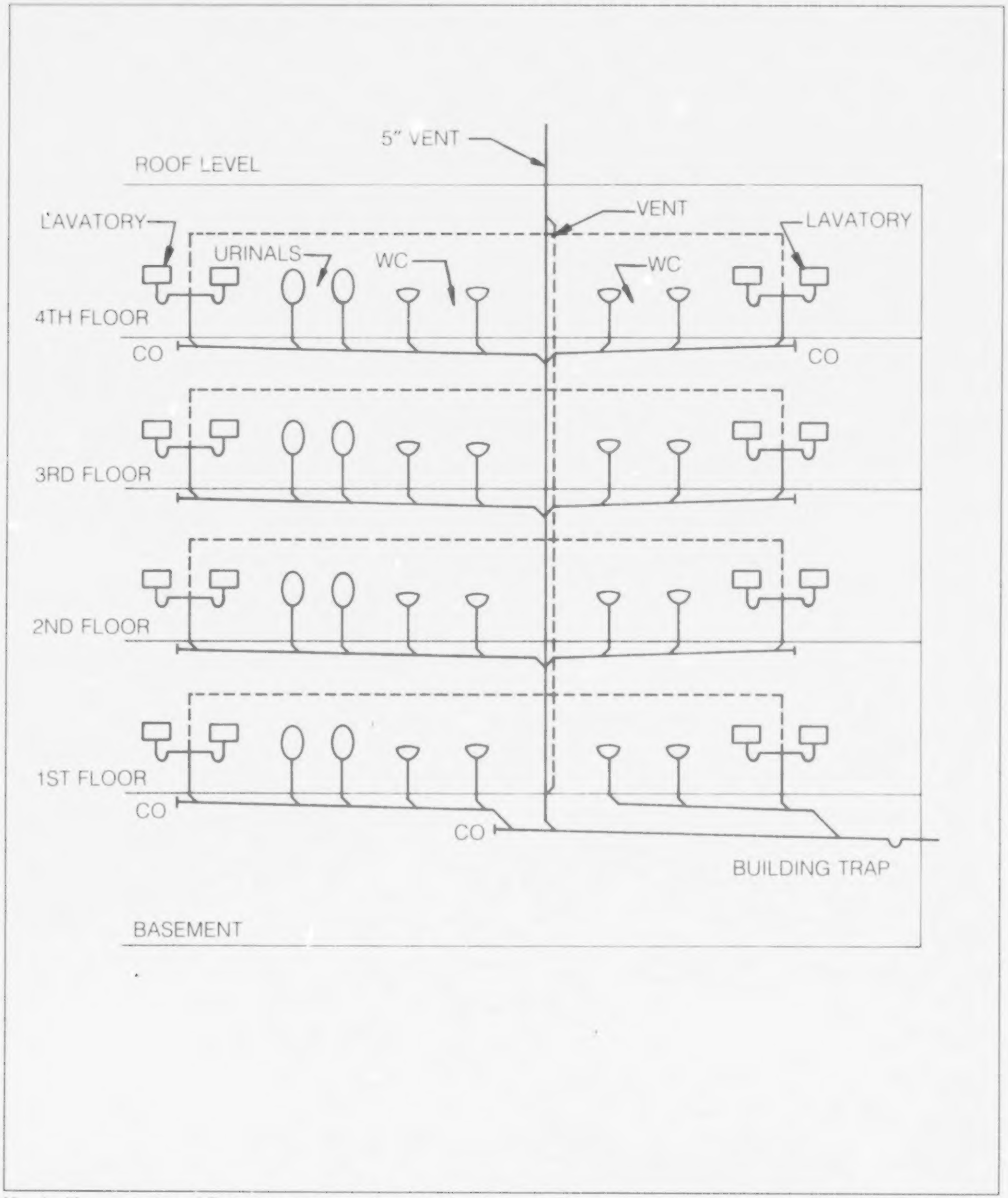

18
17
16
15
14
13
M
L
K
J
I
H
WATER HEATER
¾" H & C
SS
JANITOR
2" RISER
¾" H & 1½" C
½" H & C
LAV
MEN
1" C
½" H & 1½" C
WC
U
1" C
WC
½" H & C
LAV
WOMEN
HALL
TOILET ROOM PLAN
(TYPICAL FOR 1ST TO 4TH FLOORS)

Courtesy of Jack W Risheberger & Associates, State College, Pennsylvania.

INFORMATION SHEET

b. **Riser drawing** (elevation view) (Figure 7)—Schematic illustration of plumbing system drawn in a full-section view through structure

FIGURE 7: Riser drawing

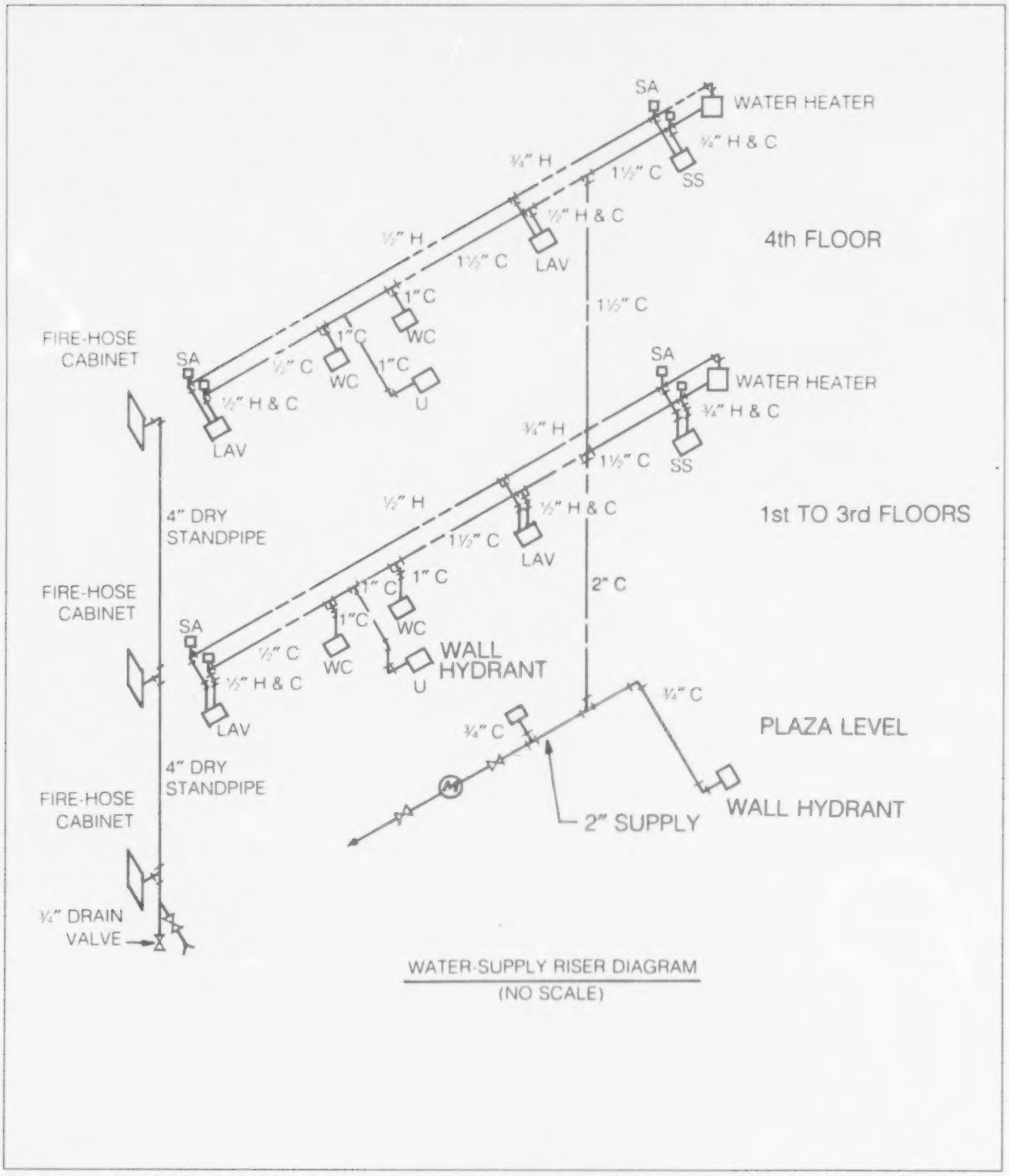

5" VENT
ROOF LEVEL
VENT
LAVATORY
LAVATORY
URINALS
WC
WC
4TH FLOOR
CO
CO
3RD FLOOR
2ND FLOOR
1ST FLOOR
CO
CO
BUILDING TRAP
BASEMENT

Used with permission of Robert M. Hettema from *Mechanical and Electrical Building Construction* by Robert M. Hettema, copyright 1984.

INFORMATION SHEET

c. **Isometric drawing** (Figure 8)—Pictorial drawing in which all horizontal lines are drawn at a 30-degree angle from the horizontal and all vertical lines are drawn at a 90-degree angle from the horizontal

FIGURE 8: Isometric drawing


SA
WATER HEATER
¾" H & C
¾" H
1½" C
SS
½" H & C
4th FLOOR
½" H
1½" C
LAV
1" C
WC
1½" C
FIRE-HOSE CABINET
SA
½" C
1" C
WC
1" C
U
½" H & C
LAV
SA
WATER HEATER
¾" H & C
¾" H
1½" C
SS
½" H
½" H & C
1st TO 3rd FLOORS
4" DRY STANDPIPE
1½" C
LAV
1" C
1" C
2" C
FIRE-HOSE CABINET
WC
SA
1" C
½" C
WALL HYDRANT
WC
½" H & C
U
¾" C
LAV
PLAZA LEVEL
¾" C
4" DRY STANDPIPE
M
FIRE-HOSE CABINET
2" SUPPLY
WALL HYDRANT
¾" DRAIN VALVE
WATER-SUPPLY RISER DIAGRAM
(NO SCALE)

Courtesy of Jack W Risheberger & Associates, State College, Pennsylvania.

INFORMATION SHEET

13. Factors to consider when deciding which type of drawing to use to illustrate piping and plumbing plans

NOTE: When completing piping and plumbing plans, it is common for a drafter to use a combination of drawing types to convey all necessary information about a particular plumbing system. The drafter must decide which drawings would best illustrate the components of the piping and plumbing plans to be developed. Listed below are factors drafters can use in deciding which drawings to use.

a. **Plan drawing**

(1) Does not show height dimensions or slope of piping

(2) Shows length of pipe

(3) Shows location and type of fittings

(4) Shows location of floor drains

(5) Indicates direction of water flow

(6) Can be used to calculate labor estimates for installation and materials

(7) Provides a permanent record of pipe, fittings, and valve locations after floor has been installed or poured

b. **Riser drawing** (riser diagram)

(1) Provides schematics of piping, fittings, valves, fixtures, and all other plumbing components

(2) Indicates all height dimensions and location of system components

(3) Indicates slope angle of all piping

(4) Shows vertical alignment of all plumbing fixtures

(5) Is valuable in determining spacing requirements required by local or national codes

c. **Isometric drawing**

NOTE: Isometric drawings are the most commonly used method of representing plumbing systems for commercial structures. They are always drawn as schematic (single-line) representations.

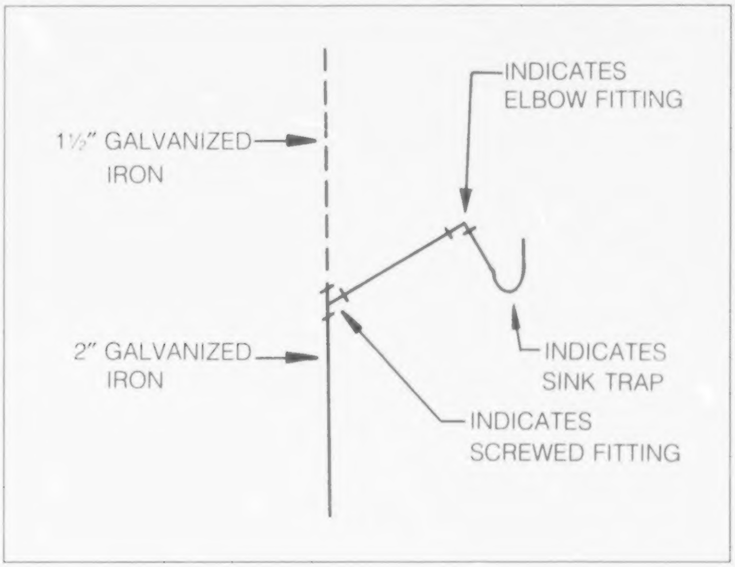
(1) Combines the advantages of plan and riser drawings into one three-dimensional illustration, showing length, height, and depth of components in one drawing

INFORMATION SHEET

(2) Shows all fittings and valves in system

NOTE: The short vertical lines used in isometric drawings show all fittings and valves in the plumbing system. See Figure 9.

FIGURE 9


1½" GALVANIZED IRON
INDICATES ELBOW FITTING
2" GALVANIZED IRON
INDICATES SINK TRAP
INDICATES SCREWED FITTING

PLUMBING SYSTEMS
UNIT 8

STUDENT SUPPLEMENT 1—CALCULATING TOTAL FIXTURE UNITS PER STRUCTURE AND DETERMINING REQUIRED DIAMETER OF BUILDING SEWER LINE

Study the following building description and sample problem below to learn the steps in calculating total fixture units per structure and in determining the required diameter of the building sewer line for a structure. You will also use Student Supplement 2, "Equivalent Fixture Units," and Student Supplement 3, "Capacities of Building Drains and Sewers," in following through the sample problem.

Building description

The building—a one-story motel—consists of 40 rooms. Each of the 40 rooms contains the following fixtures:

- 1 private lavatory
- 1 private flush-tank water closet
- 1 private bathtub with shower over

In addition, the manager's office contains 1 private lavatory, 1 flush-tank water closet, and 1 bathtub with shower over. And there are 2 public stall urinals and 4 private laundry tubs.

The slope (fall) of the pipe is to be ⅛ inch to 1 foot.

A. Determine total fixture units per structure.

1. Determine total number of fixture types per structure.

   For the building described above,

   - There are 41 private lavatories in the structure.
   - There are 41 private flush-tank water closets in the structure.
   - There are 41 private bathtubs with shower over.
   - There are 2 public stall urinals.
   - There are 4 private laundry tubs.

2. Determine equivalent fixture-unit number for each fixture type from appropriate fixture-unit table. See the table in Student Supplement 2.

   According to the table in Student Supplement 2,

   - The equivalent fixture-unit number for 1 private lavatory is 1.
   - The equivalent fixture-unit number for 1 private flush-tank water closet is 3.
   - The equivalent fixture-unit number for 1 private bathtub with shower over is 2.
   - The equivalent fixture-unit number for 1 public stall urinal is 5.
   - The equivalent fixture-unit number for 1 private laundry tub is 2.

STUDENT SUPPLEMENT 1

3. Determine total fixture units per fixture type: for each fixture type, multiply total number of fixtures per structure (determined in step 1) times equivalent fixture-unit number for that fixture type (determined in step 2).

   Or,

   - 41 private lavatories × 1 fixture-unit number = 41 fixture units.
   - 41 private flush-tank water closets × 3 = 123 fixture units.
   - 41 private bathtubs with shower over × 2 = 82 fixture units.
   - 2 public stall urinals × 5 = 10 fixture units.
   - 4 private laundry tubs × 2 = 8 fixture units.

4. Determine the total fixture units per structure: add all total fixture units per fixture type.

   Or,

   41 fixture units + 123 fixture units + 82 fixture units + 10 fixture units + 8 fixture units = 264 total fixture units per structure.

B. Determine required diameter of building sewer line.

1. Determine slope (fall) of pipe required by structure.

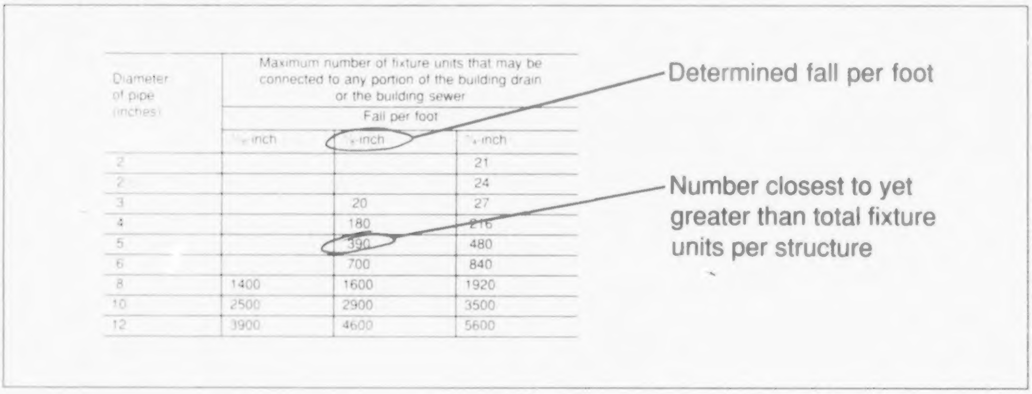
   For the building described above, the required slope is ⅛ inch fall to the foot.

2. Obtain appropriate capacity chart for building drains and sewers. See the table in Student Supplement 3.

3. Locate on table the column showing the fall per foot required by structure, and then locate under this column the number equal to—or the closest number greater than—the total fixture units per structure, which was calculated in section A above. See Figure 1.

   For the building described above, the fall per foot is ⅛ inch and the total fixture-units number is 264 (see Figure 1).

FIGURE 1



Diameter of pipe (inches)	Maximum number of fixture units that may be connected to any portion of the building drain or the building sewer		
	Fall per foot		
	1/16-inch	⅛-inch	¼-inch
2			21
2			24
3		20	27
4		180	216
5		390	480
6		700	840
8	1400	1600	1920
10	2500	2900	3500
12	3900	4600	5600

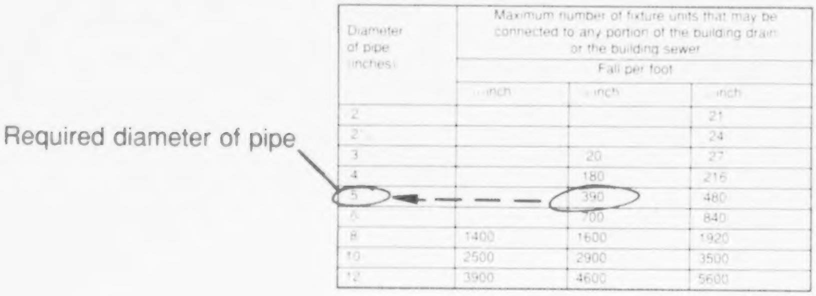
Determined fall per foot

Number closest to yet greater than total fixture units per structure

STUDENT SUPPLEMENT 1

4. From number determined in step 3, read left across table to determine required diameter of pipe (in inches) for building sewer line. See Figure 2.

FIGURE 2



Required diameter of pipe

Diameter of pipe (inches)	Maximum number of fixture units that may be connected to any portion of the building drain or the building sewer		
	Fall per foot		
	[illegible] inch	[illegible] inch	[illegible] inch
2			21
2½			24
3		20	27
4		180	216
5		390	480
6		700	840
8	1400	1600	1920
10	2500	2900	3500
12	3900	4600	5600

PLUMBING SYSTEMS
UNIT 8

STUDENT SUPPLEMENT 2—EQUIVALENT FIXTURE UNITS

Fixture	Number of fixture units		Minimum trap size
	Private use	Public use	
Bar sink	1	2	1½
Bathtub (with or without shower over)	2	4	1½
Dental unit or cuspidor	-	1	1½
Drinking fountain (each head)	-	1	1¼
Hose bibb or sill cock (standard type)	3	5	
House trailer (each)	6	6	3
Laundry tub or clotheswasher (each pair of faucets)	2	4	1½
Lavatory	1	2	1½
Lavatory (dental)	1	1	1½
Lawn sprinklers (standard type, each head)	1	1	
Shower (each head)	2	4	1½
Sink (bar)	1	2	1½
Sink or dishwasher	2	4	1½
Sink (flushing rim, clinic)	-	10	3
Sink (washup, each set of faucets)	-	2	1½
Sink (washup, circular spray)	-	4	1½
Urinal (pedestal or similar type)	-	10	3
Urinal (stall)	-	5	2
Urinal (wall)	-	5	1½
Urinal (flush tank)	-	3	1½
Water closet (flush tank)	3	5	3
Water closet (flushometer valve)	6	10	3

PLUMBING SYSTEMS
UNIT 8

STUDENT SUPPLEMENT 3—CAPACITIES OF BUILDING DRAINS AND SEWERS

Diameter of pipe (inches)	Maximum number of fixture units that may be connected to any portion of the building drain or the building sewer		
	Fall per foot		
	1/16-inch	1/8-inch	1/4-inch
2			21
2½			24
3		20	27
4		180	216
5		390	480
6		700	840
8	1400	1600	1920
10	2500	2900	3500
12	3900	4600	5600

PLUMBING SYSTEMS
UNIT 8

STUDENT SUPPLEMENT 4—GUIDELINES FOR USING THE *UNIFORM PLUMBING CODE*

The *Uniform Plumbing Code* is a handbook published by the International Association of Plumbing and Mechanical Officials. The handbook provides useful information concerning design and construction requirements for residential, commercial, and industrial plumbing systems.

The handbook is divided into 13 chapters involving specific areas of plumbing systems. Those chapter headings are listed in Table 1 below.

Chapters are further divided into specific topic areas called *sections*. Each section is given a three-digit identifying number (i.e., the sections in Chapter 4 would be section 401, section 402, section 403, section 404, etc.).

Sections may be further subdivided into paragraphs, which are identified by a letter designation (i.e., Section 401 [a]).

As you learned in Unit 1, "Introduction to Architectural Drafting," you must use the identifying three-digit number and letter designation to locate topics within chapters, sections, and paragraphs. An extensive index at the back of the book provides the appropriate identifying number for a specific topic you wish to locate.

TABLE 1: Chapter headings

Chapter number	Chapter heading
1	Definitions
2	Materials and alternates
3	General regulations
4	Drainage systems
5	Vents and venting
6	Indirect and special wastes
7	Traps and interceptors
8	Joints and connections
9	Plumbing fixtures
10	Water distribution
11	Building sewers
12	Fuel gas piping
13	Water heaters and vents

PLUMBING SYSTEMS
UNIT 8

STUDENT SUPPLEMENT 5—GUIDELINES FOR COMPLETING PLUMBING-SYSTEM DRAWINGS

In developing working drawings of a structure's plumbing system, you should first consider factors relating to the complexity of the system.

- If the plumbing system is not complex, both the water-distribution and waste-disposal system may be drawn together on a single drawing.
- If the plumbing system is complex, the water-distribution and waste-disposal systems should be drawn as separate drawings.

Second, you should consider the type of drawing that would best illustrate the structure's water-distribution and waste-disposal systems.

- Will each drawing you develop be best illustrated as a plan drawing, a riser drawing, or an isometric drawing? Review Objective 13 in the information sheet to help you make this decision, and remember that it is common to use a combination of drawing types to convey all the necessary information about a particular plumbing system.

Third, you should consider working drawings to be used as the basis for the type of drawing you have selected to use.

- If you are developing a plan-view drawing, you should use the floor-plan drawings as underlays to locate all plumbing fixtures and potential plumbing walls.
- If you are developing a riser drawing, you should use the elevation views as underlays to locate all plumbing fixtures and necessary height dimensions.

Finally, you should use the following steps in creating each drawing you have decided to develop of the structure's plumbing system.

Steps in completing plumbing and piping plans

1. Locate all plumbing fixtures by placing symbols in the appropriate location.

   NOTE: Remember to use floor-plan or elevation drawings as underlays, if required.

2. Locate the main water-supply line coming into the structure and then run cold-water lines to required fixtures. Label pipe sizes, fittings, and valves.
3. Locate water-heating system and then run all hot-water lines to required fixtures. Label pipe sizes and fittings.
4. Locate main sewer line and then run all soil and waste lines vertically through the structure. Label all pipe sizes and fittings.

STUDENT SUPPLEMENT 5

5. Locate and run all branch lines from fixtures to vertical soil and waste stacks. Indicate cleanouts and necessary vent stacks. Label pipe sizes and fittings.
6. Finalize linework by using heavy lines to emphasize all plumbing-related materials.
7. Draw a legend on the sheet to explain line-type usage meanings of special symbols.
8. Add complete notes indicating materials, installation instructions, manufacturer's information, etc.

PLUMBING SYSTEMS
UNIT 8

ASSIGNMENT SHEET 1—CALCULATE TOTAL FIXTURE UNITS PER STRUCTURE AND DETERMINE REQUIRED DIAMETER OF BUILDING SEWER LINE FOR A COMMERCIAL STRUCTURE

Name ______________________ Score ____________

Introduction

Before a plumbing system can be started, the sizes of all pipes, traps, and feeder lines must be determined. This determination is done by first calculating the total fixture units in a structure and then using a reference chart to determine the diameter of the pipe required in a building with that total fixture-unit number. In this assignment sheet, you will practice making these calculations and determinations.

Exercise

Directions

Study the sample problem presented in Student Supplement 1, "Calculating Total Fixture Units per Structure and Determining Required Diameter of Building Sewer Line." Also study the tables presented in Student Supplements 2 and 3 and the building description presented below. Then calculate the total number of fixture units per structure and determine the diameter of the building sewer line required for the building described. Show your calculations on the back of this page, and write your answers on the blanks provided below the building description.

Building description

The building—a four-story office building—contains the following plumbing fixtures per floor:

- 6 wall-mounted urinals
- 4 public lavatories
- 7 public flush-tank water closets

In addition, the building contains 2 private bar sinks and 1 faucet washup sink. There are also 26 lawn-sprinkler heads for the exterior landscaping.

Answers to problem

Total fixture units per structure ____________

Diameter of building sewer pipe required in structure ________

PLUMBING SYSTEMS
UNIT 8

ASSIGNMENT SHEET 2—USE THE *UNIFORM PLUMBING CODE* TO ANSWER QUESTIONS ABOUT COMMERCIAL PLUMBING SYSTEMS

Name ______________________ Score ____________

Introduction

A knowledge of the format and information contained in the *Uniform Plumbing Code* (UPC) handbook is important when a drafter is designing or drawing plumbing plans. Below are questions designed to help you become more familiar with the handbook.

Exercise

Directions

Obtain a copy of the *Uniform Plumbing Code*, 8th edition, and study the information presented in Student Supplement 4, "Guidelines for Using the *Uniform Plumbing Code*," while looking at the format of the handbook. Then use the handbook to answer the questions presented below. Fill in each of the blanks provided below or provide the information requested.

1. Refer to section 117 (a) of the UPC handbook. What does the abbreviation "PB" stand for?

   "PB" stands for ______________________

2. Refer to section 771 (b). What is the minimum flow rate for a commercial grease trap?

   Minimum flow rate ______________________

3. Refer to section 1307 (a). What shall fuel-burning water heaters be assured a sufficient supply of for proper fuel combustion?

   Fuel-burning water heaters shall be supplied __________

   ____

4. Refer to section 1107 (a). Additional building sewer cleanouts shall be installed at intervals not to exceed how many feet in straight runs?

   Number of feet ______________________

5. Refer to section 403, Table 1. What is the minimum trap and trap-arm size for a commercial or industrial sink?

   Minimum size ______________________

ASSIGNMENT SHEET 2

6. Refer to section 612 (f). Are you allowed to connect a chemical vent to vents that supply other services?

   Circle the correct answer Yes No

PLUMBING SYSTEMS
UNIT 8

ASSIGNMENT SHEET 3—DEVELOP A PLAN DRAWING OF A COMMERCIAL PLUMBING SYSTEM

Name ______________________________ Score ______________

Introduction In this assignment sheet, you will practice completing a plan drawing of the fire-station drawings you have developed in previous units.

Exercise

Directions Locate the floor-plan drawing of the fire station you completed in Unit 4, Assignment Sheet 3, and dimensioned in Unit 7, Assignment Sheet 2. Mark up a print of your floor-plan drawing to include the location of all desired plumbing fixtures, such as fixtures found in bathrooms and kitchens, water fountains, outside hose bibbs, water heaters, and other water sources.

Review the information presented in the information sheet and study the additional information presented in Student Supplement 5, "Guidelines for Completing Plumbing-System Drawings." Then, using the fire station's floor-plan drawing as an underlay, develop a plumbing plan. Indicate all fixtures, pipes, fittings, valves, traps, and cleanouts on the drawing. Also, be sure to include a symbols' legend and any appropriate notes.

PLUMBING SYSTEMS
UNIT 8

ASSIGNMENT SHEET 4—DEVELOP AN ISOMETRIC DRAWING OF A COMMERCIAL PLUMBING SYSTEM

Name ______________________ Score ____________

Introduction In this assignment sheet, you will develop the type of drawing most commonly used for drawing a plumbing layout—the isometric drawing.

Exercises

Part A

Directions Review the information presented in Student Supplement 5, "Guidelines for Completing Plumbing-System Drawings." Then, using the plumbing plan drawing you developed in Assignment Sheet 3 as a guide, draw an isometric view of the plan on a separate sheet of paper. Have your instructor evaluate your isometric drawing.

Part B

Directions When your instructor is satisfied as to the appearance of the isometric drawing you completed in Part A, redraw the isometric view so that it fits into the upper-right-hand corner of your plumbing plan drawing. Label the isometric view accordingly.

PLUMBING SYSTEMS
UNIT 8

WRITTEN TEST

Name ______________________________ Score ____________

1. Define terms associated with plumbing systems. Write your answers on the blanks provided beside each term below.

   a. Fitting ______________________________

   ____

   b. Fixture unit ______________________________

   ____

   c. Riser ______________________________

   ____

   d. Stack ______________________________

   ____

2. Match major types of plumbing systems to their correct descriptions. Write the numbers on the blanks provided.

   ______a. System in which pipes and valves or fittings are used to conduct natural or manufactured gas to fuel-burning plumbing fixtures

   ______b. System in which water pumps are placed at lower and upper ends of building to provide water throughout structure at calculated quantities and pressure

   ______c. System in which a pump operates to keep a sealed tank filled with water to compress air trapped in tank at a desired pressure

   ______d. System in which pumps placed in basement of building pump water into tanks placed at top of building and pressure is created when water flows downward by the force of gravity

   1. Hydropneumatic system
   2. Gravity system
   3. Direct system
   4. Gas-piping system

WRITTEN TEST

3. Describe the major subsystems of a plumbing system. Write your answers on the blanks provided by each of the terms below.

   a. Water-distribution system ______________________________

   ____

   ____

   b. Waste-disposal system ______________________________

   ____

   ____

4. Match components of a water-distribution system to their correct definitions. Write the numbers on the blanks provided. Definitions continue on the next page.

_____a. Main supply pipe used to convey water into structure from community water system

_____b. Short sections of supply pipe that extend beyond last fitting on line; used to prevent water hammer

_____c. Device used to measure volume of water passing through main water-supply line at entrance to structure

_____d. Piping for transporting cold water from one location to another within structure

_____e. Piping for transporting hot water from water heater to other locations within structure

_____f. Plumbing devices that stop the flow of water in the direction opposite its normal flow

_____g. Control devices for regulating flow of water

_____h. Appliance used to heat water

_____i. Faucets or taps threaded so a hose may be attached to carry water

1. Main water-supply line
2. Water meter
3. Valves
4. Backflow preventers
5. Cold-water pipes
6. Hot-water pipes
7. Water heater
8. Bibbs
9. Air chambers
10. Drain softener
11. Shock absorbers

WRITTEN TEST

______j. Devices in piping system used to reduce shock that occurs when water flow is suddenly obstructed

______k. Filtering system designed to remove sediment deposits from the main water supply

5. List 5 of the 8 characteristics of a well-designed water-distribution system for a commercial structure. Write your answers on the blanks provided below.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

6. Match the major parts of a waste-disposal system to their correct descriptions. Write the numbers on the blanks provided. Descriptions continue on the next page.

______a. Large vertical pipes that accept liquid waste from fixtures not receiving solid waste and discharges it into soil pipe or building drain

______b. Large vertical pipes that accept solid wastes from water closets and conducts it to building drain

______c. Pipe fittings with removable plug placed at end of horizontal piping runs to allow access to waste-disposal system for cleaning and inspection

______d. Vertical pipes extending above building to allow air flow into waste piping

______e. U-shaped fittings located near each fixture; retain water to act as a seal to prevent gases from backing up through fixture and into structure

______f. Pieces of equipment attached to plumbing piping system

1. Vent stacks
2. Soil stacks
3. Waste stacks
4. Building drain
5. Building sewer branch
6. Fixtures
7. Fixture branches
8. Traps
9. Cleanouts

WRITTEN TEST

______ g. Slightly pitched horizontal pipes that carry waste water to main vertical waste stacks

______ h. Large pipe that carries discharge from soil and waste pipes from building drain to public sewer

______ i. Drain that receives discharge from soil and waste pipes and carries it to building sewer branch

7. List 4 of the 6 characteristics of a well-designed waste-disposal system for a commercial structure. Write your answers on the blanks provided below.

a. ______________________________

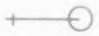
b. ______________________________

c. ______________________________

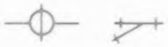
d. ______________________________

8. Identify piping symbols and abbreviations. Write your answers on the blanks provided under each of the illustrations below.

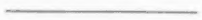
Soil, waste pipe
Gas piping
Globe valve
Tee—turned down
Elbow—turned up
Gate valve
Vent
Meter
Lateral
Elbow—90-degree
Elbow—turned down
Tee—turned up
Cold-water piping
Cleanout
Tee—straight
Elbow—45-degree
Hot-water piping



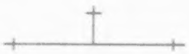
a. ______________________



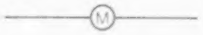
b. ______________________



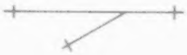
c. ______________________



d. ______________________

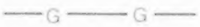


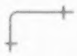
e. ______________________



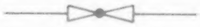
f. ______________________

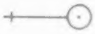
WRITTEN TEST



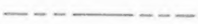


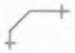
g. ______________________ h. ______________________





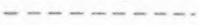
i. ______________________ j. ______________________



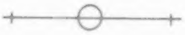


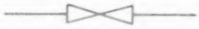
k. ______________________ l. ______________________

CW

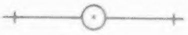


m. ______________________ n. ______________________



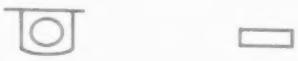


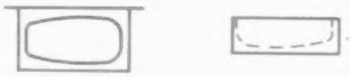
o. ______________________ p. ______________________



q. ______________________

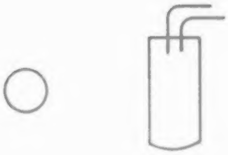
9. Label the following plan- and elevation-view plumbing-fixture symbols. Write your answers on the blanks provided under each of the illustrations below.



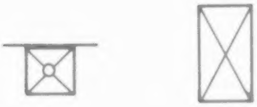


a. ______________________ b. ______________________

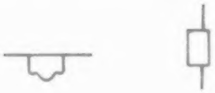
WRITTEN TEST



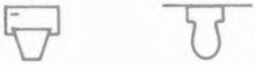
c. ______________________



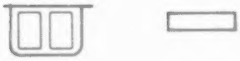
d. ______________________



e. ______________________



f. ______________________



g. ______________________

10. Define types of plans drawn for commercial plumbing systems. Write your definitions on the blanks provided beside each of the terms below.

a. Piping plan ______________________

b. Plumbing plan ______________________

11. Describe drawing methods used in completing plumbing and piping plans. Write your answers on the blanks provided beside each of the terms below.

a. Double-line method ______________________

b. Single-line method ______________________

WRITTEN TEST

12. Distinguish among descriptions of the types of drawings done for piping and plumbing plans. Write a PD on the blank before the description of a plan drawing, write an RD before the description of a riser drawing, and an ID before the description of an isometric drawing.

_____a. Pictorial drawing in which all horizontal lines are drawn at a 30-degree angle from the horizontal and all vertical lines are drawn at a 90-degree angle from the horizontal

_____b. Schematic illustration of plumbing system drawn in a full-section view through the structure

_____c. Plan-view drawing showing the plumbing or piping plan as viewed from directly above—the same view as shown on a floor-plan drawing

13. Under each of the items below, list 2 factors to consider when deciding which type of drawing to use to illustrate piping and plumbing plans. Write your answers on the blanks provided.

a. Plan drawing

(1) ______________________________

(2) ______________________________

b. Riser drawing

(1) ______________________________

(2) ______________________________

c. Isometric drawing

(1) ______________________________

(2) ______________________________

HVAC SYSTEMS
UNIT 9

UNIT OBJECTIVE

After completing this unit, the student should be able to recognize descriptions of types of heating and cooling systems, label illustrations of ventilation systems, and identify HVAC drafting symbols. The student should also be able to use standard HVAC handbooks and manuals, prepare equipment schedules, and develop an HVAC plan. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with HVAC systems to their correct definitions.
2. State definitions of abbreviations commonly used in HVAC design.
3. Define the term *air-conditioning*.
4. List the major subsystems of an HVAC system.
5. Match major types of commercial heating systems to their correct descriptions.
6. Distinguish between definitions of classifications of cooling systems.
7. Describe major types of central cooling systems.
8. List basic components of a ventilation system.
9. Label types of ventilation systems.
10. Match climatic zones in the 48 adjacent states of the United States to their correct descriptions.
11. List factors used in determining HVAC-system size requirements.
12. Match standard HVAC system-design handbooks and specification manuals to descriptions of the type of information contained in each book.
13. Identify HVAC-system drafting symbols.
14. State purposes of types of HVAC equipment schedules.
15. Use standard HVAC system-design handbooks to answer questions concerning HVAC systems. (Assignment Sheet 1)
16. Develop an HVAC plan. (Assignment Sheet 2)
17. Develop equipment schedules. (Assignment Sheet 3)

HVAC SYSTEMS
UNIT 9

SUGGESTED ACTIVITIES

Preparation

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery and Application" section and plan classroom activities. Also note suggestions for media and supplemental materials.

- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section.
- Make transparencies from the transparency masters included in this unit.
- Prepare classroom and lab. Put up posters, charts, and signs; display articles and other references related to the objectives of this unit.

Delivery and Application

Unit introduction

- Provide students with objective sheet. Discuss unit and specific objectives.
- Invite a local architect to talk to the class about HVAC-system design and the particular problems system design poses within the framework of planning and construction.
- Provide students with information sheet.

Objective 1 Match terms associated with HVAC systems to their correct definitions.

Objective 2 State definitions of abbreviations commonly used in HVAC design.

Objective 3 Define the term *air-conditioning.*

- Treat Objectives 1, 2, and 3 as a unit explaining the new terms and the abbreviations students will encounter in the design of an HVAC system.
- When possible, show examples that illustrate terms and make examples available in the classroom.

SUGGESTED ACTIVITIES

Objective 4 List the major subsystems of an HVAC system.

- Read with students and discuss the note introducing the objective. Then, using a plan drawing of an HVAC system, trace the subsystems of the system illustrated.

- Emphasize the job performed by each of the subsystems in an HVAC system.

Objective 5 Match major types of commercial heating systems to their correct descriptions.

- Discuss the types of heating systems presented in the objective, stating the advantages and disadvantages of each type. Use Transparency 1, "Forced Warm-Air System," to illustrate the components and basic workings of that type of system.

- Determine the type of heating system utilized in your school by examining the types of air-supply outlets present and studying their locations. Then, take the class to visit the school's mechanical room to actually examine the central heating unit.

Objective 6 Distinguish between definitions of classifications of cooling systems.

Objective 7 Describe major types of central cooling systems.

- Discuss Objective 6, reviewing the definitions of the classifications of cooling systems. Then discuss the four types of central cooling systems presented in Objective 7. Stress the advantages and disadvantages of each type of system.

Objective 8 List basic components of a ventilation system.

Objective 9 Label types of ventilation systems.

- Discuss the basic components of a ventilation system presented in Objective 8. And then, locate diffusers, grilles, and registers in your school building.

- Use Transparencies 2 and 3 to illustrate your discussion of the types of ventilation systems presented in Objective 9. Stress to students that these are the systems most commonly used. Discuss typical applications of each type of system.

SUGGESTED ACTIVITIES

Objective 10 Match climatic zones in the 48 adjacent states of the United States to their correct descriptions.

- Discuss the descriptions for the four climatic zones presented in the objective. Use Transparency 4, "Climatic-Zone Map," and the figure in the objective to illustrate your discussion.
- Determine the climatic zone for the area you live in and discuss the relationship between the climate of your zone and the type of HVAC system that is typically installed in buildings in your area.

Objective 11 List factors used in determining HVAC-system size requirements.

- Read to students the note introducing the objective in the information sheet. Then, further explain the basic concepts of heat-loss and heat-gain calculations.
- Invite a representative from a local utility company to demonstrate to the class a sample heat-loss and heat-gain calculation scenario.
- Take the class to visit a local sheet-metal fabrication shop that specializes in the manufacture of HVAC mechanical systems. Have students examine the HVAC plans that the fabrication shop receives from the drafter.

Objective 12 Match standard HVAC system-design handbooks and specification manuals to descriptions of the type of information contained in each book.

- Read the introduction to the information sheets, discussing the industry-recognized standards books for HVAC design. Show students a copy of each book and explain the format and content of each.
- Hand out Assignment Sheet 1, "Use Standard HVAC System-Design Handbooks to Answer Questions Concerning HVAC Systems." Read with students the introduction and directions to the assignment, answer any student questions, and have students complete Assignment Sheet 1.

Objective 13 Identify HVAC-system drafting symbols.

- Discuss with students the symbols as presented in the illustrations in the information sheet. Then draw each of the symbols on the chalkboard, explaining each symbol's meaning and an application of the symbol on a drawing as you are drawing.

SUGGESTED ACTIVITIES

- Hand out Assignment Sheet 2, "Develop an HVAC Plan," and Student Supplement 1, "Guidelines for Completing an HVAC Plan."
- Discuss with students the drawing sequence presented in the student supplement. Use Transparency 5, "Typical HVAC Plan," and the figure in the student supplement to illustrate your discussion.
- Draw a simple HVAC plan on the chalkboard, following the sequence presented in the supplement.
- Discuss with students the directions in the exercise presented in Assignment Sheet 2 and examine with them the HVAC-system specifications. Present possible HVAC-design solutions to students and answer any student questions. Have students complete Assignment Sheet 2.
- Invite a HVAC specialist to attend a class session and evaluate the HVAC plans students complete in Assignment Sheet 2. Have the specialist offer suggestions for improving student plans or answer any student questions.

Objective 14 State purposes of types of HVAC equipment schedules.

- Read with students the note introducing the objective in the information sheet. Stress the importance of a drafter's providing accurate and complete equipment schedules.
- Examine the examples of the equipment schedules shown in Tables 2 through 5 in the information sheet. Point out the types of information presented in each type of schedule.
- Hand out Assignment Sheet 3, "Develop Equipment Schedules." Read to students the introduction and directions to the exercises in the assignment sheet. Answer any student questions and have students complete Assignment Sheet 3.

Evaluation

- Give written test.
- Compile written-test and assignment-sheet scores on Unit Evaluation Form.
- Reteach and retest as required.

SUGGESTED ACTIVITIES

Suggested Resources

Resources used in developing unit

Print media

- *ASHRAE Handbook*. Atlanta, Georgia: American Society of Heating, Refrigeration, and Air-Conditioning Engineers, 1982.
- Callendar, John. *Time Saver Standards for Architectural Design Data*, 6th ed. New York: McGraw-Hill, 1982.
- Hettema, Robert M. *Mechanical and Electrical Building Construction*. Englewood Cliffs, New Jersey: Prentice-Hall, 1984.
- Muller, Edward J. *Architectural Drawing and Light Construction*. Englewood Cliffs, New Jersey: Prentice-Hall, 1985.
- Traister, John E. *Practical Drafting for the HVAC Trades*. Indianapolis, Indiana: Howard W. Sams and Company, 1981.
- *Uniform Mechanical Code*. Walnut, California: International Association of Plumbing and Mechanical Officials, 1988.

Additional resources

Print media

- Brumbaugh, James E. *Heating, Ventilation, and Air-Conditioning Library*. Indianapolis, Indiana: Howard W. Sams and Company, 1981.
- Putnam, Robert E. *Building Trades Blueprint Reading*. Reston, Virginia: Reston Publishing Company, Inc., 1986.
- Sizemore, Michael M. *Energy Planning for Buildings*. New York: American Institute of Architects, 1979.

HVAC SYSTEMS
UNIT 9

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

1. General criteria for commercial and public buildings
2. Section 1, Chapter 6
3. Section 7, Chapter 59
4. 7 square inches per 1000 Btu's of output
5. Environmental-air duct
6. Section 5, Chapter 33
7. a. Calculating heat load
   b. Selecting appropriate temperatures
   c. Calculating heat-load components
   d. Internal-heat-source considerations
   e. Pick-up load for buildings

Assignment Sheet 2

Evaluated to the satisfaction of the instructor.

Assignment Sheet 3

Part A

EVALUATOR'S NOTE: The schedule should be in chart form with appropriate descriptions. The descriptions should include the following information.

- Heat pump—Lennox
- Model number—CBP10-51
- Heating capacity—61,400 Btuh
- Cooling capacity—48,900 Btuh
- Cooling-air volume—1600 cfm
- Heating-air volume—1600 cfm
- Cooling compressor (watts input)—3960
- Heating compressor (watts input)—4495
- Line voltage—230v-60hz-1ph
- Energy efficiency rating (EER)—8.2
- Coefficient of performance (COP)—2.9

Part B

Evaluated to the satisfaction of the instructor.

HVAC SYSTEMS
UNIT 9

ANSWERS TO WRITTEN TEST

1. a. 4
   b. 8
   c. 2
   d. 11
   e. 1
   f. 3
   g. 5
   h. 9
   i. 6
   j. 10
   k. 7
   l. 12
   m. 13

2. a. Abbreviation for British thermal unit; amount of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit at a specified temperature
   b. Abbreviation for British thermal unit per hour; unit of measure used to express hourly heat flow in a structure
   c. Abbreviation for cubic feet per minute; unit of measure used to express air flow
   d. Abbreviation for heat-transfer factor; value used to express heat flow through 1 square foot of a structural component at specific design conditions
   e. Numeric value given as a measure of the effectiveness of a material's ability to resist heat transfer

3. Controlling of temperature, humidity, ventilation, air motion, and air quality within a structure

4. a. Heating system
   b. Cooling system
   c. Ventilation system

5. a. 1
   b. 3
   c. 5
   d. 4
   e. 2

6. a. US
   b. CS

7. a. Cooling system in which air is passed over cooling coils and then into rooms through diffusers
   b. Cooling system in which chilled water is circulated through a coil over which room air passes
   c. Cooling system in which air is passed over a water-chilled coil

ANSWERS TO WRITTEN TEST

8. a. Blower
   b. Ductwork
   c. Supply-air outlets
   d. Return-air outlets

9. a. Extended-plenum duct system
   b Radial duct system

10. a. 2
    b. 4
    c. 3
    d. 1

11. Answer should include any 6 of the following

    a. Size of structure
    b. R-value of building materials used in construction of structure
    c. Outside design temperature
    d. Inside design temperature
    e. Design-temperature difference
    f. Heat-transfer factors of building components
    g. Heat gain
    h. Duct heat loss and duct heat gain

12. a. 3
    b. 4
    c. 1
    d. 2
    e. 5

13. a. Supply outlet
    b. Duct (plan)
    c. Recirculation duct (section)
    d. Medium-pressure return
    e. Wall return outlet
    f. Compressed air
    g. Fresh-air duct (section)
    h. Convector
    i. Register
    j. Radiator
    k. Thermostat
    l. Exhaust inlet
    m. Supply duct (section)
    n. Exhaust duct (section)
    o. Furnace
    p. Wall supply outlet
    q. High-pressure steam
    r. Diffuser (round, ceiling)

14. a. Indicates the manufacturer, model number, size, building location, and air-handling capacity in cubic feet per minute of each grille or diffuser used in a structure
    b. Presents various components of the description of a boiler
    c. Describes hot-water or steam baseboard radiators in schedule form so that only a radiator number need be assigned on the HVAC drawing
    d. Describes each unit heater to be used in a structure to keep the HVAC drawing from becoming crowded with informational callouts for each unit shown on the drawing

HVAC SYSTEMS
UNIT 9

UNIT EVALUATION FORM

Student name ______________________________ Unit rating __________

Assignment sheet ratings

Assignment Sheet 1—Use Standard HVAC System-Design Handbooks to Answer Questions Concerning HVAC Systems Rating __________

Comments: ______________________________

____

Assignment Sheet 2—Develop an HVAC Plan Rating __________

Comments: ______________________________

____

Assignment Sheet 3—Develop Equipment Schedules Rating __________

Comments: ______________________________

____

Written test scores

Pretest __________ Other __________

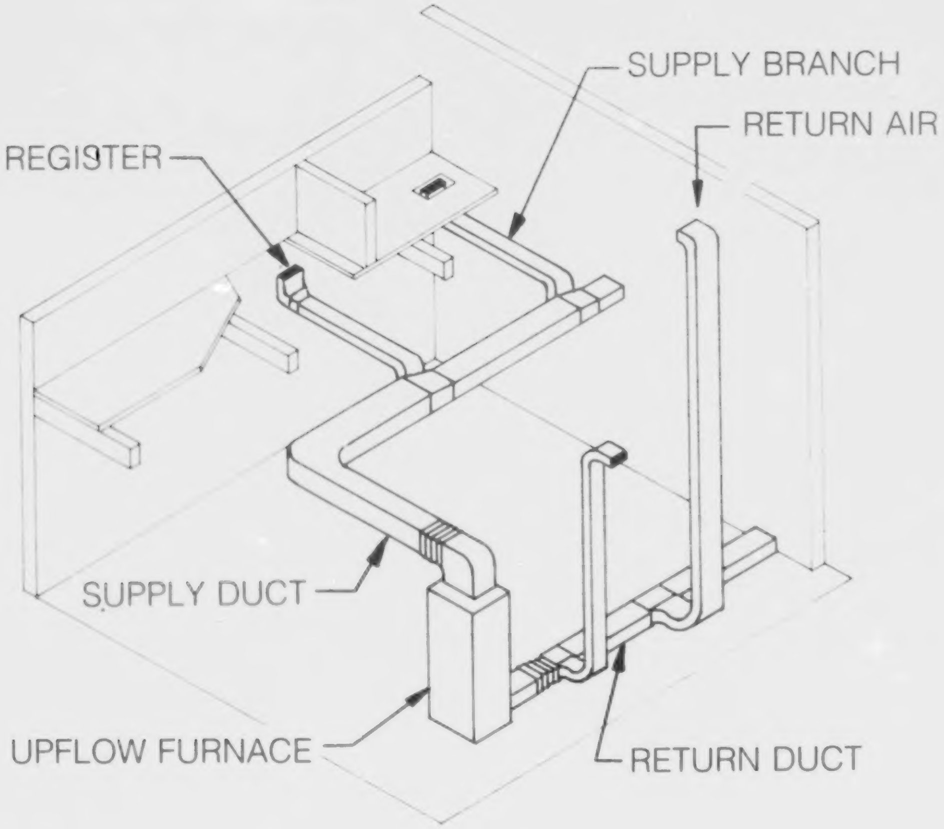
Posttest __________

Instructor signature ______________________________ Date __________

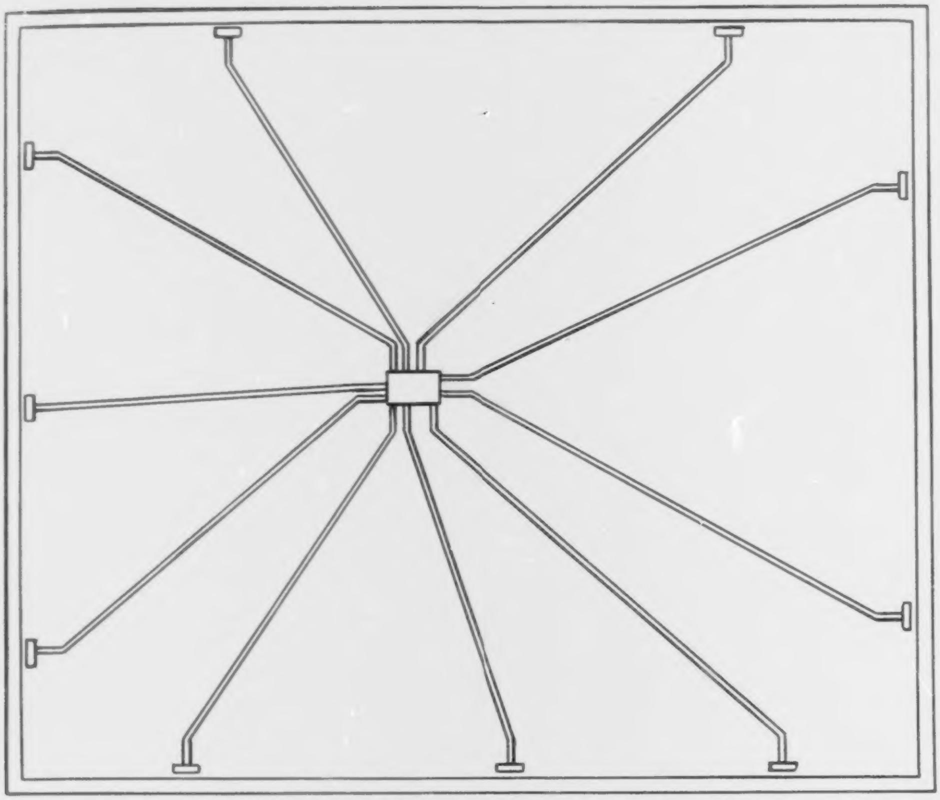
Student signature ______________________________ Date __________

Duplication of this form is permitted.

Forced Warm-Air System

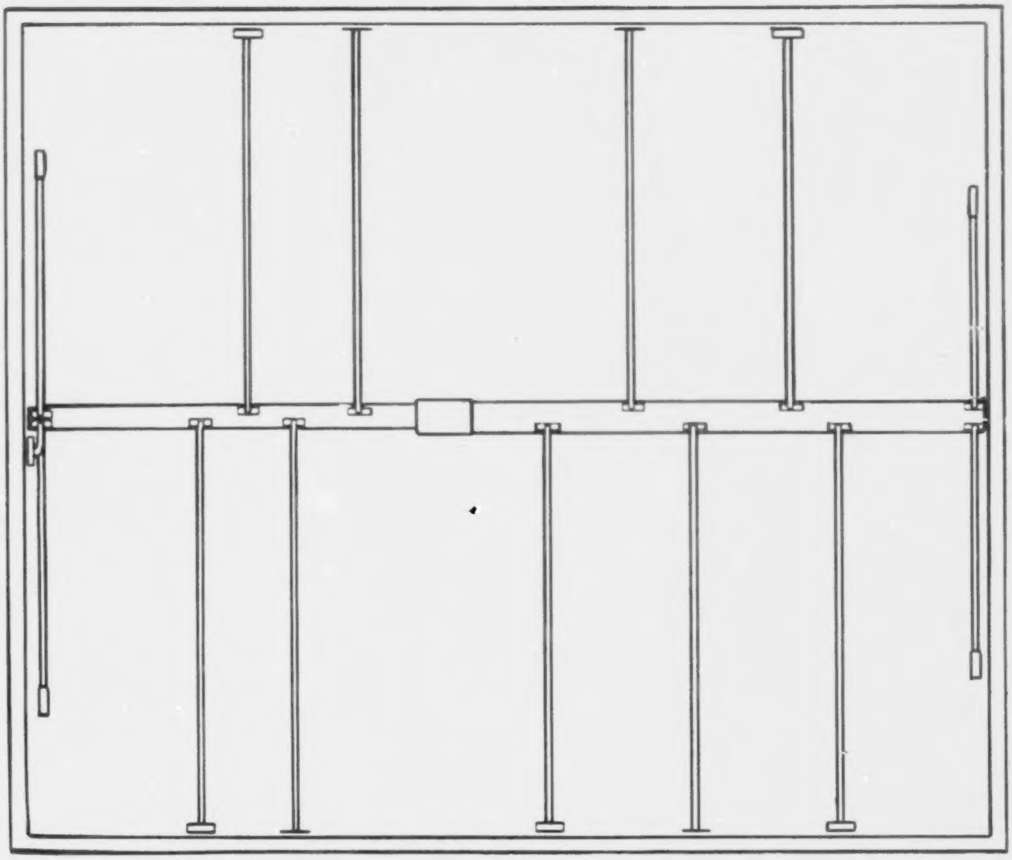

SUPPLY BRANCH
RETURN AIR
REGISTER
SUPPLY DUCT
UPFLOW FURNACE
RETURN DUCT

Radial Duct System

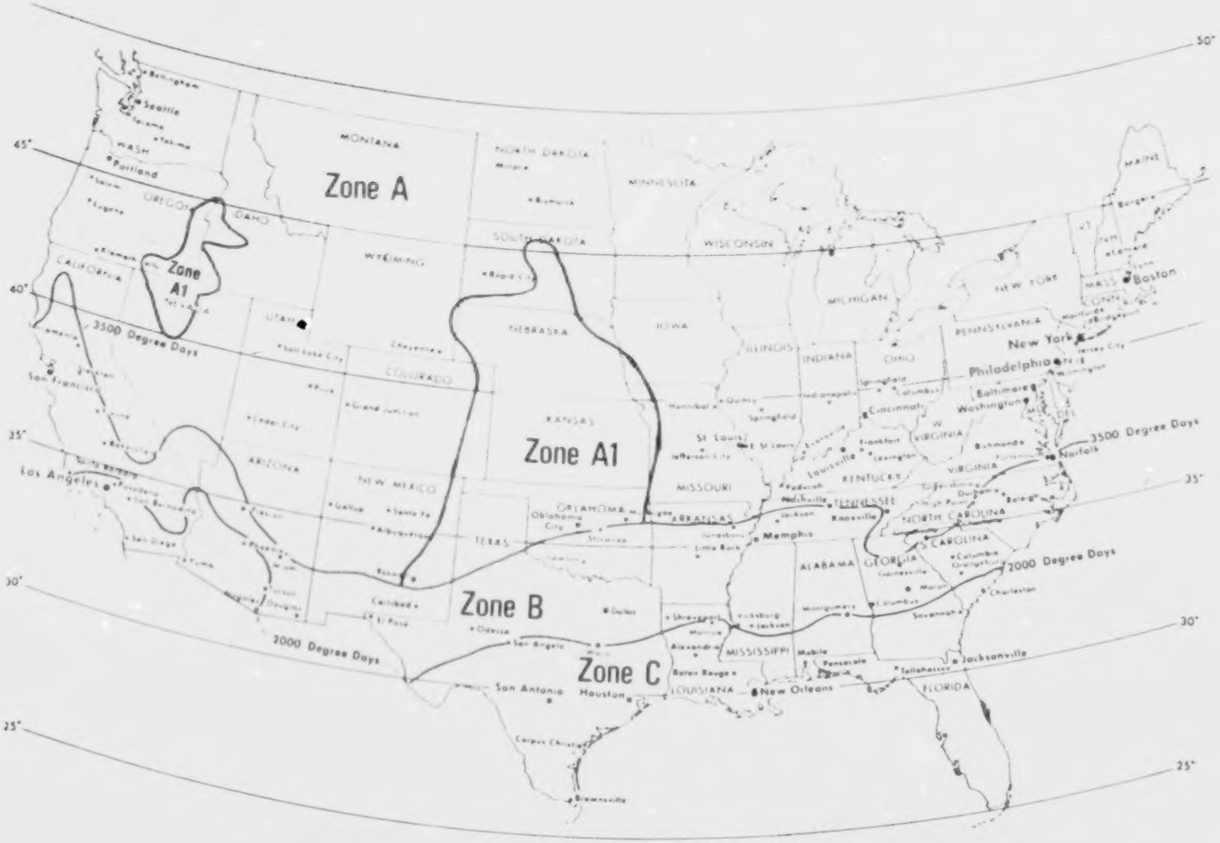


AD-555

Extended-Plenum Duct System

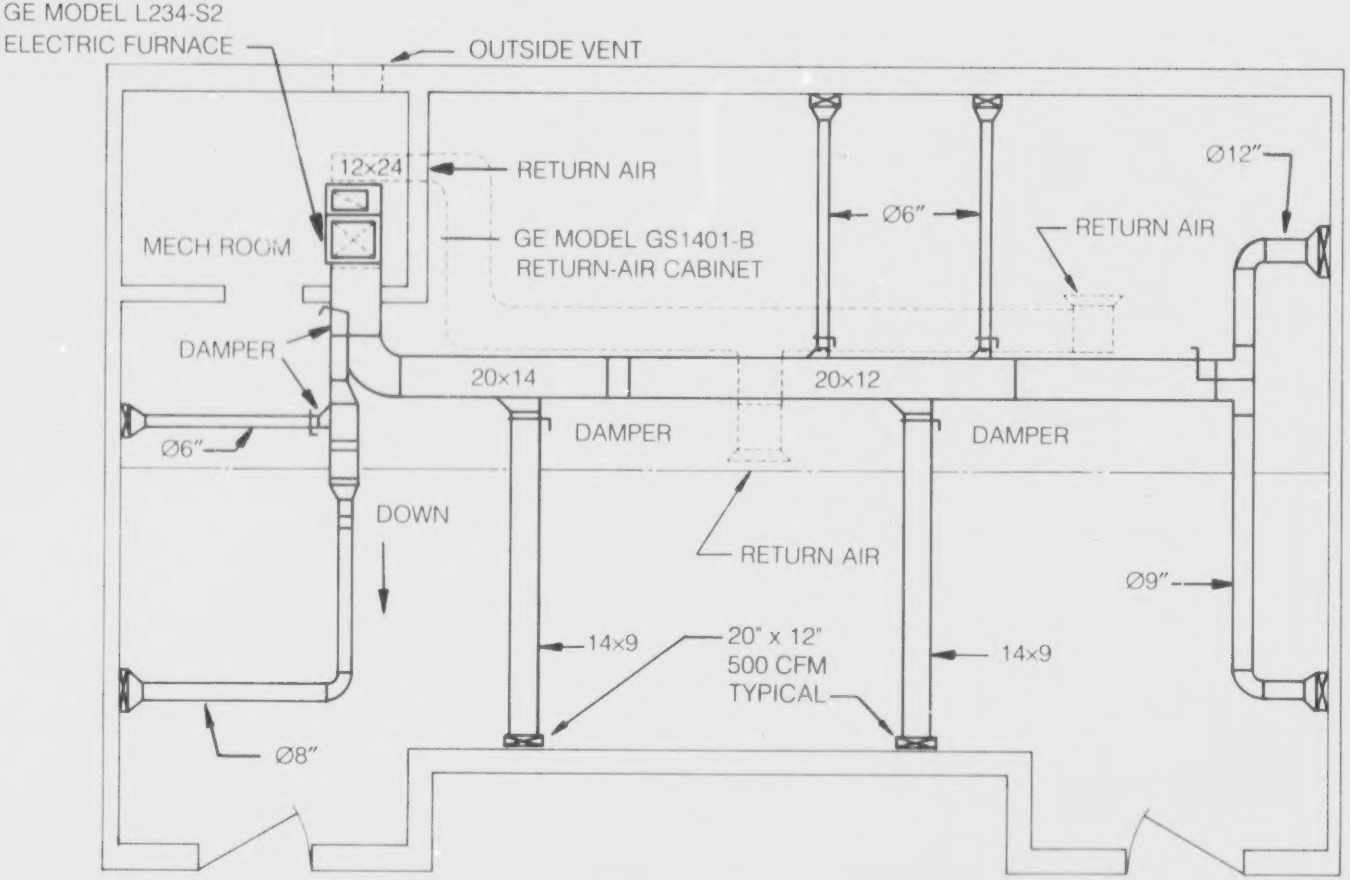


Climatic-Zone Map


Zone A
Zone A1
Zone A1
Zone B
Zone C
3500 Degree Days
3500 Degree Days
2000 Degree Days
2000 Degree Days
50°
45°
40°
35°
35°
30°
30°
25°
25°
Seattle
Portland
WASH
OREGON
IDAHO
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
WISCONSIN
MICHIGAN
WYOMING
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
NEW YORK
PENNSYLVANIA
MAINE
MASS
Boston
CONN
New York
Philadelphia
Baltimore
Washington
CALIFORNIA
NEVADA
UTAH
COLORADO
KANSAS
MISSOURI
St Louis
KENTUCKY
VIRGINIA
W VIRGINIA
Norfolk
San Francisco
Los Angeles
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
Memphis
TEXAS
ALABAMA
GEORGIA
MISSISSIPPI
LOUISIANA
New Orleans
FLORIDA
Jacksonville
San Antonio
Houston
Dallas

Courtesy of Air-Conditioning Contractors of America, Washington, D.C.

Typical HVAC Plan


GE MODEL L234-S2
ELECTRIC FURNACE
OUTSIDE VENT
12×24
RETURN AIR
MECH ROOM
GE MODEL GS1401-B
RETURN-AIR CABINET
Ø6″
RETURN AIR
Ø12″
DAMPER
20×14
20×12
Ø6″
DAMPER
DAMPER
DOWN
RETURN AIR
Ø9″
14×9
20″ x 12″
500 CFM
TYPICAL
14×9
Ø8″

HVAC SYSTEMS
UNIT 9

INFORMATION SHEET

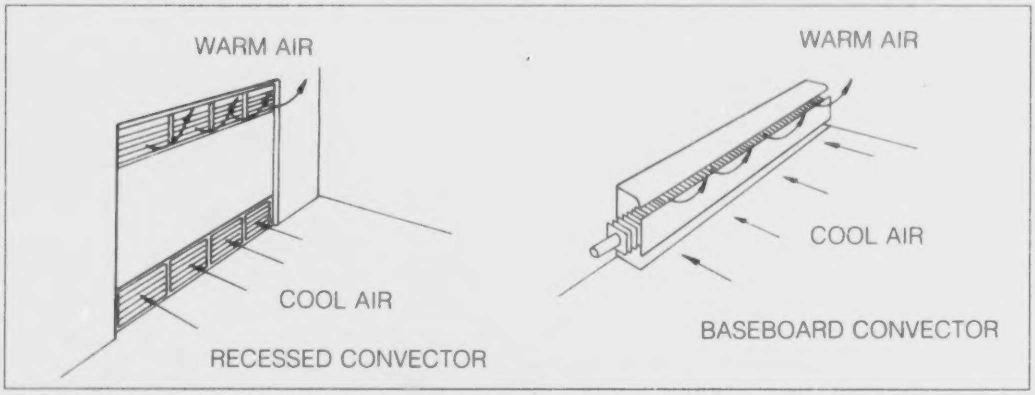
1. **Terms and definitions associated with HVAC systems**

   a. **Boiler**—Closed tank connected to an energy source that heats water to a high temperature

   NOTE: A boiler is usually connected to a pump to distribute water or steam for heating or power purposes.

   b. **Convector** (Figure 1)—Surface designed to transfer its heat from a fluid to surrounding air, as in a steam- or water-heat system

FIGURE 1



From READING ARCHITECTURAL PLANS: For Residential and Commercial Construction, 3e, © 1989, p. 135, by Ernest Weidhaas. Reprinted by permission of Prentice-Hall, Englewood Cliffs, New Jersey.

   c. **Damper**—Device used to regulate air flow

   d. **Diffuser**—Register that emits air flow in a radial or fan-like pattern

   e. **Duct**—Rectangular or cylindrical sheet-metal-enclosed channel through which air is moved in an air-distribution system

   f. **Exhaust duct**—Duct that is part of the system used to remove air from an enclosed area and discharge it into the atmosphere

   g. **Fresh-air duct**—Duct that is part of the system used to vent fresh air into an air-distribution system

   h. **Furnace**—Heating system in which heat is transferred from the point of combustion to the air supplied to the system; section of a boiler in which combustion occurs

   i. **Grille**—Louvered plate usually found in an air-return opening

INFORMATION SHEET

j. **Plenum**—Large chamber into which an air-handling system (heating or cooling) discharges air or returns air

k. **Radiator**—Device that transfers heat from steam or hot water to the room air

l. **Register**—Grille that contains a damper to help regulate air flow

m. **Thermostat**—Automatic temperature-sensitive device that opens and closes a circuit to regulate the temperature of an area

2. **Abbreviations commonly used in HVAC design and their definitions**

a. **Btu**—Abbreviation for British thermal unit; amount of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit at a specified temperature (such as 39 degrees Fahrenheit)

b. **Btuh**—Abbreviation for British thermal unit per hour; unit of measure used to express hourly heat flow

c. **Cfm**—Abbreviation for cubic feet per minute; unit of measure used to express air flow

d. **HTF**—Abbreviation for heat-transfer factor; value used to express heat flow (Btu's) through 1 square foot of a structural component at specific design conditions

e. **R-value**—Numeric value given as a measure of the effectiveness of a material's ability to resist heat transfer

3. **Definition of the term *air-conditioning***—Controlling of temperature, humidity, ventilation, air motion, and air quality within a structure

4. **Major subsystems of an HVAC system**

NOTE: HVAC systems consist of three major subsystems—heating, cooling, and ventilation. These three subsystems comprise the air-conditioning capabilities of any HVAC system.

a. **Heating system**

b. **Cooling system**

c. **Ventilation system** (air-distribution system)

NOTE: *Ventilation* is defined as "controlled air that is brought into and exhausted from a structure."

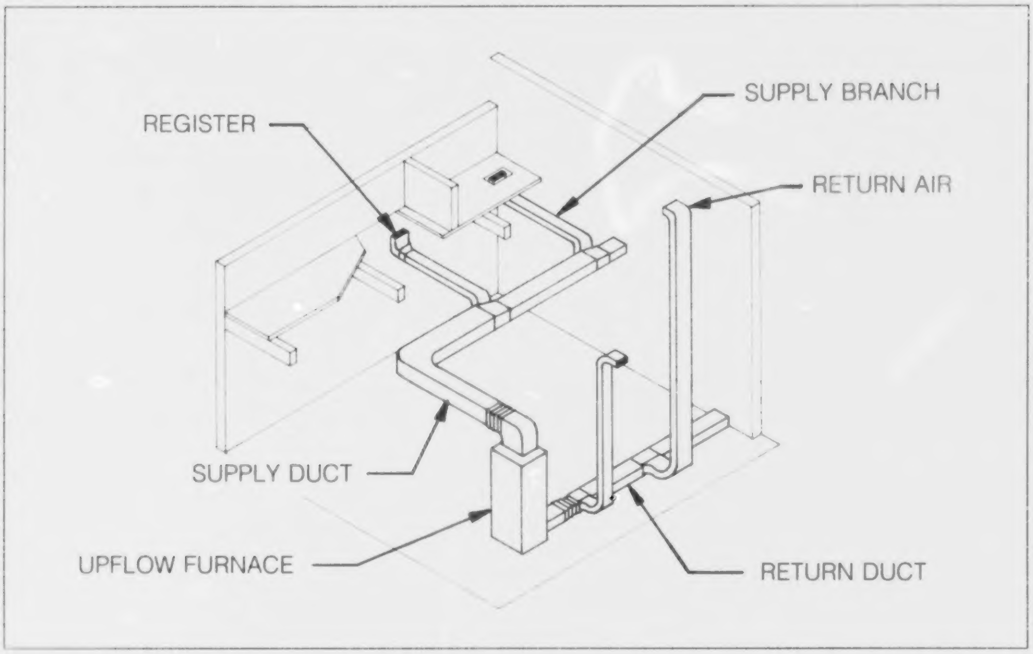
5. **Major types of commercial heating systems and their descriptions**

NOTE: The systems listed below are the major types of heating systems used in commercial applications today.

a. **Forced-air system** (see Figure 2)—System using a furnace to heat the air and fans and a system of supply ducts and branches, registers, and diffusers to circulate the warmed air throughout a structure

INFORMATION SHEET

FIGURE 2: Forced-air system



b. **Forced-circulation hot-water system**—System using a boiler to heat water, a system of flexible tubing and narrow piping to circulate heated water throughout structure, and wall-mounted convectors that force out air heated by circulating hot water

c. **Steam-heat system**—System using a boiler to create steam that is circulated through structure in a system of pipes and then to radiators that warm the air in each room

d. **Electric-heat system**—System using an electric heater that produces heat by passing electrical current through resistive wires; heat is then dispersed by means of a fan or transferred to a sealed water supply

NOTE: Although inexpensive to install and easy to control, electric heat is not commonly used in commercial applications because of the high cost of operating this type of system and because of the system's inability to control air circulation and humidity.

e. **Solar-heat system**—System using a solar collector to capture sun's radiation and convert it to heat

NOTE: Though rarely used in commercial buildings today, solar-heat systems may someday become a valuable alternative to current methods of heating a structure because of the rising fossil-fuel costs and the environmental concerns associated with fossil-fuel use.

INFORMATION SHEET

6. **Classifications of cooling systems and their definitions**

   a. **Central system**—Cooling system that is an integral part of the heating system and uses the same distribution system

   b. **Unitary system**—Cooling system that is separate from the heating system and uses its own distribution system

   NOTE: Unitary systems are packaged as single units (usually roof-top mounted) that supply cool air to isolated areas (i.e., motel rooms, school rooms).

7. **Major types of central cooling systems and their descriptions**

   a. **Air system**—Cooling system in which air is passed over cooling coils and then into rooms through diffusers

   b. **Water system**—Cooling system in which chilled water is circulated through a coil over which room air passes

   c. **Air and water system**—Cooling system in which air is passed over a water-chilled coil

8. **Basic components of a ventilation system**

   a. **Blower** (fan)

   b. **Ductwork**

   c. **Supply-air outlets**

   NOTE: Supply-air outlets are the means of efficiently distributing conditioned air into a room by controlling the flow rate, air noise, and direction (diffusion) of the air. Diffusers, grilles, or registers are used as supply-air outlets, depending upon the requirements of the room or of the space being conditioned.

   d. **Return-air outlets**

   NOTE: Return-air outlets are used to return conditioned air back to its original source in order to be conditioned again. As a rule, return-air outlets are placed opposite supply-air ducts or in the ceiling in commercial structures.

9. **Types of ventilation systems**

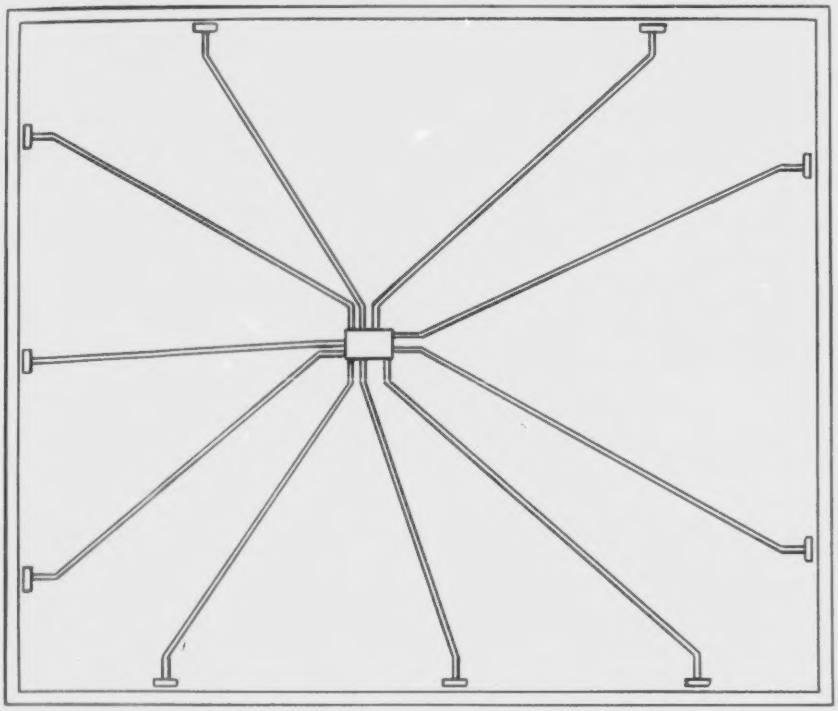
   NOTE: All of the heated and cooled air produced by the various mechanical systems must be distributed throughout a structure through the ventilation system. A good ventilation system will deliver the heated and/or cooled air to rooms and spaces with a minimum of resistance and a maximum of efficiency.

   a. **Radial duct system** (see Figure 3)

   NOTE: A radial duct system is comprised of a centrally located furnace plenum with supply ducts that extend out to various locations within the structure.

INFORMATION SHEET

FIGURE 3: Radial duct system

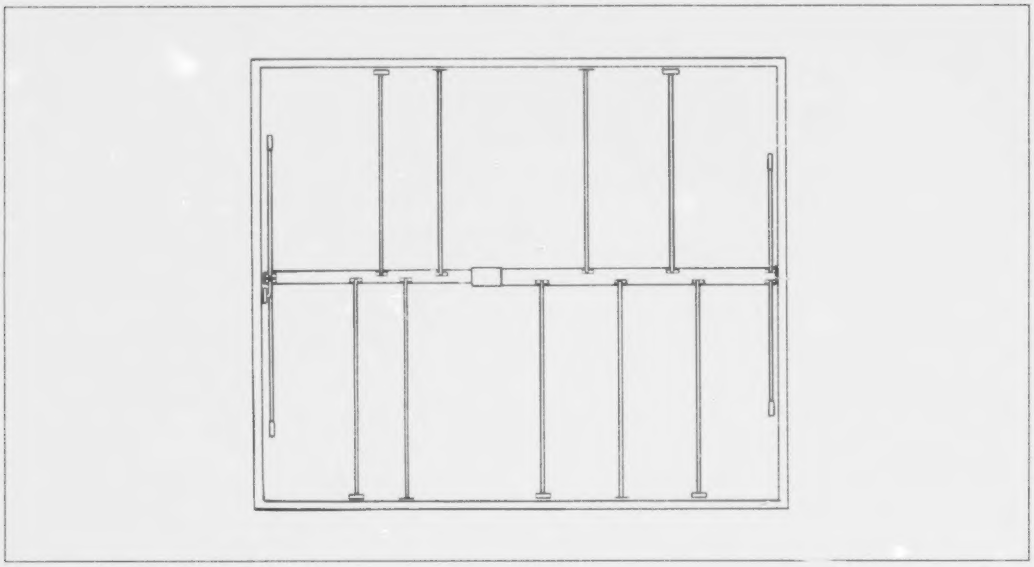


b. **Extended-plenum duct system** (see Figure 4)

NOTE: An extended-plenum duct system is made up of a large, rectangular duct that extends directly from the furnace plenum and branch (feeder) ducts that project from the large *extended* duct.

INFORMATION SHEET

FIGURE 4: Extended-plenum duct system



10. Climatic zones in the 48 adjacent states of the United States and their descriptions

NOTE: One of the significant factors that must be considered in designing a HVAC system is the climatic zone in which the structure is to be built. Listed below are the four major climatic zones identified within the 48 adjacent states in the United States. See Figure 5.

a. **Zone A**—Zone with severe and prolonged winters and summers that are relatively mild

NOTE: For structures in Zone A, the HVAC-system design must have an extremely efficient heating system.

b. **Zone A-1**—Zone with severe and prolonged winters but with summer temperatures that are, on average, higher than those found in Zone A

NOTE: For structures in Zone A-1, the HVAC-system design must address both heating and cooling requirements.

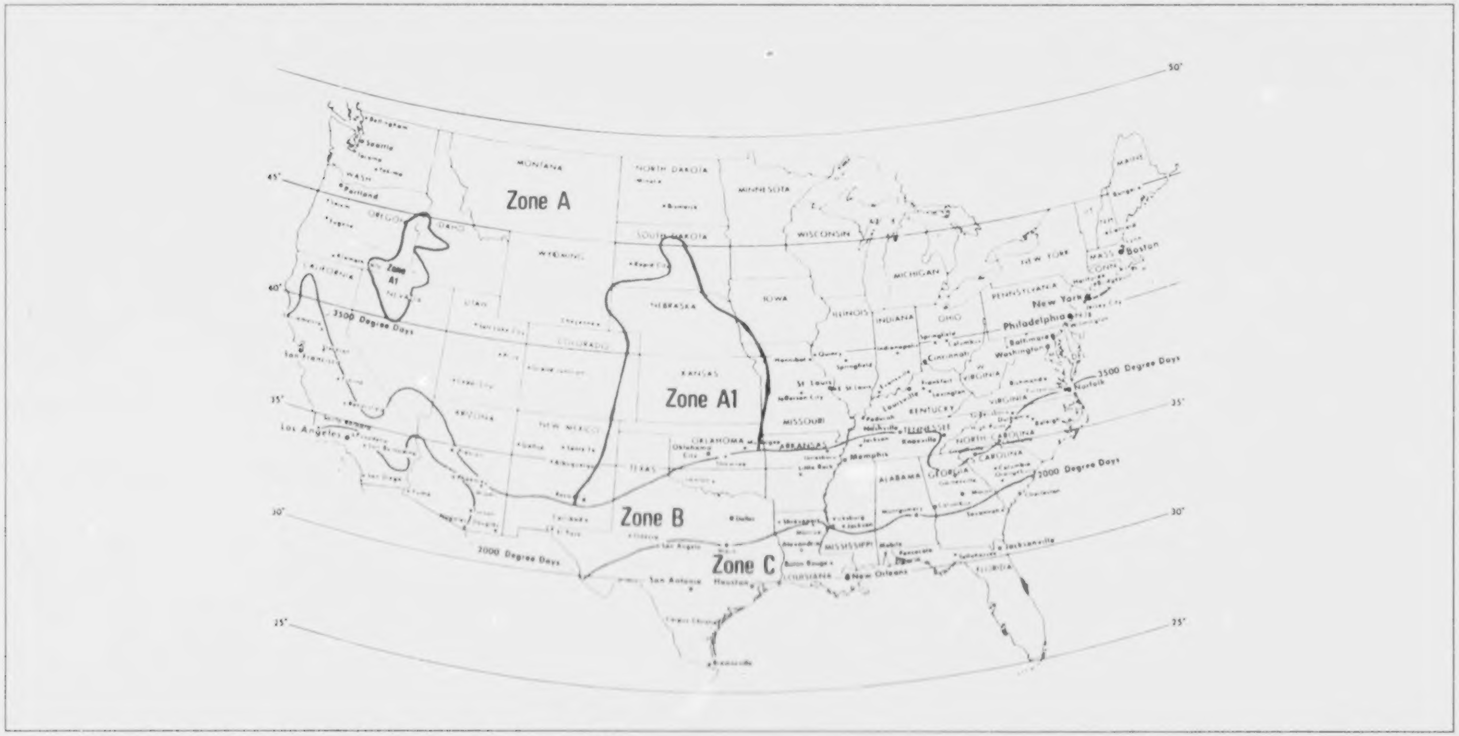
c. **Zone B**—Zone with moderate winters and summers with extended periods of hot days

NOTE: The HVAC-system design for structures in Zone B must provide a well-balanced heating and cooling system.

d. **Zone C**—Zone with mild winters and hot summers

NOTE: The HVAC-system design for structures in Zone C must provide an extremely efficient air-conditioning system.

FIGURE 5: Climatic-zone map


Zone A
Zone A1
Zone A1
Zone B
Zone C
3500 Degree Days
3500 Degree Days
2000 Degree Days
2000 Degree Days
50°
45°
40°
35°
30°
25°
Seattle
Portland
Los Angeles
Boston
New York
Philadelphia
Baltimore
Washington
Norfolk
Memphis
New Orleans
Houston
San Antonio
Jacksonville
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
WISCONSIN
MICHIGAN
NEW YORK
PENNSYLVANIA
WYOMING
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
COLORADO
KANSAS
MISSOURI
KENTUCKY
VIRGINIA
UTAH
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
TEXAS
ALABAMA
GEORGIA
MISSISSIPPI
LOUISIANA
FLORIDA
OREGON
IDAHO
WASH
CALIFORNIA
MAINE

Courtesy of Air-Conditioning Contractors of America, Washington, D.C.

INFORMATION SHEET

11. **Factors used in determining HVAC-system size requirements**

NOTE: In order to properly size an HVAC system for a structure, heat-loss and heat-gain calculations must be made to determine the amount of heating or cooling that must be provided to maintain a desired temperature within a structure. Listed below are several factors used to calculate the total heat-loss or heat-gain factor for a structure.

a. **Size of structure**

NOTE: The *size* of a structure is defined as "the amount of open space to be heated or cooled."

b. **R-value of building materials used in construction of structure**

NOTE: The insulating qualities of the building materials used in a structure are assigned an R-value.

c. **Outside design temperature**

NOTE: The outside design temperature is the calculated average temperature for a specific geographic location.

d. **Inside design temperature**

NOTE: The inside design temperature is the temperature to be maintained within the structure.

e. **Design-temperature difference**

NOTE: The design-temperature difference is calculated by subtracting the outside design temperature from the inside design temperature. A positive value indicates that heating is required; a negative value indicates that cooling is required.

f. **Heat-transfer factors** (HTFs) **of building components**

NOTE: There are established heat-transfer factors for most materials used in the various building components (i.e., floor, ceiling, doors, windows, etc.). These established HTFs are used to calculate the Btuh value that is used to determine HVAC-system equipment requirements.

g. **Heat gain**

NOTE: Heat gain is the amount of heat a structure gains through all of its surfaces that adjoin spaces with different temperatures. Heat gain is measured in Btuh's.

h. **Duct heat loss and duct heat gain**

NOTE: Duct heat loss or duct heat gain occurs when the temperature of the air surrounding the ducts in the HVAC system is different from the temperature of the air flowing inside the ductwork.

INFORMATION SHEET

12. Standard HVAC system-design handbooks and specification manuals and descriptions of the type of information contained in each book

NOTE: As in other phases of architectural design, drafting, and construction, HVAC has industry-recognized handbooks and manuals that provide criteria and standards for design, construction, and installation of commercial, industrial, and residential HVAC systems.

a. ***Uniform Mechanical Code*** (UMC handbook)—Sets forth guidelines and standards for HVAC-system design in the same format developed for the *Uniform Building Code* and the *Uniform Plumbing Code*; contains five major parts: administrative, definitions and abbreviations, HVAC, refrigeration, and miscellaneous

b. ***ASHRAE Handbook—Applications Volume***—Discusses HVAC system-design criteria for specific applications in seven major areas: air-conditioning and heating—comfort, air-conditioning and heating—special and process, food refrigeration, distribution of chilled and frozen foods, low-temperature applications, industrial application of refrigeration, and general applications

NOTE: ASHRAE is the abbreviation for the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, the organization that publishes the ASHRAE volumes. The applications volume contains 59 chapters.

c. ***ASHRAE Handbook—Fundamentals Volume***—Discusses HVAC equipment design and energy calculations in six major areas: theory, general engineering data, basic materials, load and energy calculations, duct and pipe sizing, and general applications

NOTE: The fundamentals volume contains 39 chapters.

d. ***ASHRAE Handbook—Systems Volume***—Discusses specific types of HVAC systems available and lists performance criteria for each type in four major areas: air-conditioning and heating systems, industrial ventilation systems, refrigeration systems, and general applications

NOTE: The systems volume contains 47 chapters.

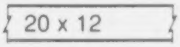
e. ***Air-Conditioning Contractors of America Manuals***—Set forth HVAC system-design and installation requirements for commercial, residential, and industrial applications

INFORMATION SHEET

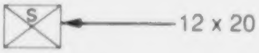
13. HVAC-system drafting symbols (Table 1)

NOTE: The symbols shown below are the standard HVAC-system drafting symbols developed by the American National Standards Institute (ANSI).

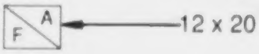
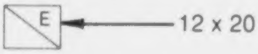
TABLE 1

Symbol name	Symbol
Compressed air	——— A ———
Medium-pressure return	—+——+—-
High-pressure steam	—//——//—
Thermostat	Ⓣ
Duct (plan)	

NOTE: The symbol will contain an identifying number. The first number (20) indicates the width of the duct; the second number (12) indicates the depth of the duct.

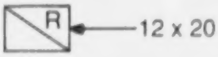
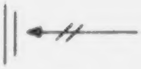
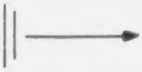
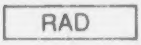
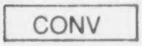
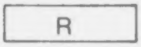
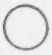
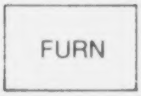
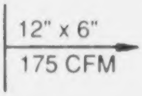
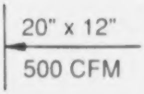
Symbol name	Symbol
Supply duct (section)	

NOTE: In the section symbol, the items in the identfying number are flipflopped from the order of appearance in the plan symbol. In the section symbol, the number for the face that you see is given first.

Symbol name	Symbol
Fresh-air duct (section)	
Exhaust duct (section)	

INFORMATION SHEET

TABLE 1 (cont.)

Symbol name	Symbol
Recirculation duct (section)	
Exhaust inlet	
Supply outlet	
Radiator	
Convector	
Register	
Diffuser (round, ceiling)	
Furnace	
Wall supply outlet	 12" x 6" 175 CFM
Wall return outlet	 20" x 12" 500 CFM

INFORMATION SHEET

14. Types of HVAC equipment schedules and their purposes

NOTE: Equipment schedules provide specific information in a single chart. Having all this information in chart form saves time and prevents erroneous placement and/or sizing of HVAC equipment within a structure. Listed below are several types of HVAC equipment schedules commonly used.

a. **Grille and diffuser schedule** (Table 2)—Indicates the manufacturer, model number, size, building location, and air-handling capacity in cubic feet per minute of each grille or diffuser used in a structure

NOTE: The "Mark" column in the table below refers to the identifying mark on the HVAC drawing.

TABLE 2

Grille and Diffuser Schedule					
Mark	**Manuf**	**Model**	**Size**	**CFM**	**Remarks**
1	Carnes	7292	12″ × 4″	157 CFM	—
2	Carnes	7261	20″ × 12″	200 CFM	—
3	Kreuger	SH4	8″ × 4″	150 CFM	Alum
4	Kreuger	S580H	14″ × 8″	300 CFM	Alum

b. **Boiler schedule** (Table 3)—Presents various components of the description of a boiler

NOTE: The description of a boiler is often quite lengthy. Therefore, presenting the description in schedule form helps clarify the various components of the description.

TABLE 3

Boiler Schedule				
Manuf	**Boiler no**	**Btu/gal**	**Btu-input**	**Flue**
American Standard	A-504	261,000	300,250	8″ × 12″

INFORMATION SHEET

c. **Radiator schedule** (Table 4)—Describes hot-water or steam baseboard radiators in schedule form so that only a radiator number need be assigned on the HVAC drawing

TABLE 4

Radiator Schedule				
Symbol	**Building location**	**Btu capacity**	**Enclosure length**	**Manufacturer and model no**
R-1	Room 123	7,750	7′-0″	Trane #R32
R-2	Conference room	12,600	15′-0″	Trane #R41
R-3	Bath #1	2,000	3′-6″	Trane #R7

d. **Unit heater schedule** (Table 5)—Describes each unit heater to be used in a structure to keep the HVAC drawing from becoming crowded with informational callouts for each unit shown on the drawing

TABLE 5

Unit Heater Schedule					
Symbol	**Building location**	**Cfm**	**Btu capacity**	**Type**	**Manuf**
UH-1	Entrance	500	40,000	Recessed horiz mount	Trane E-46
UH-2	Lobby	400	32,000	Recessed horiz mount	Trane E-42
UH-3	Storage area	400	32,000	Vertical cabinet	Trane E-24

HVAC SYSTEMS
UNIT 9

STUDENT SUPPLEMENT 1—GUIDELINES FOR COMPLETING AN HVAC PLAN

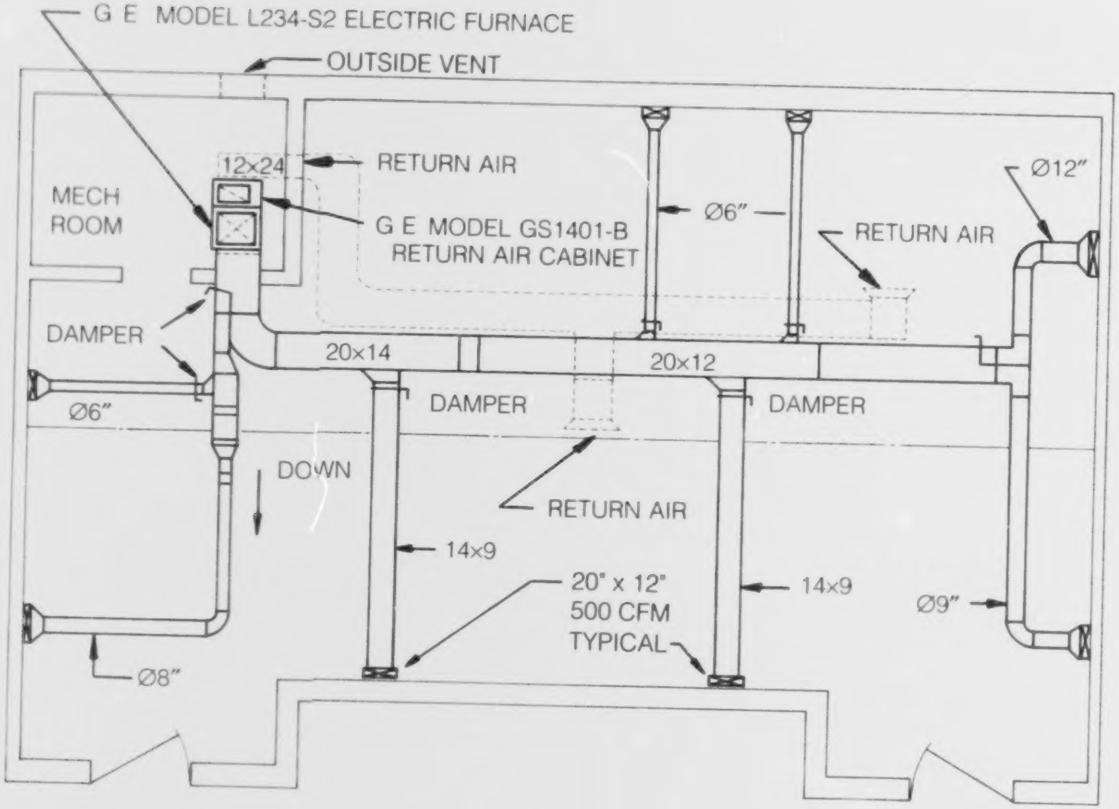
The HVAC system is almost always a plan view showing the location of the central heating and cooling unit(s), the air-distribution system (ductwork), and the air-supply and air-return outlets. See Figure 1 on the next page. The plan also shows information as to proper sizes and dimensions of the units, ductwork, outlets, etc. The following steps should be followed in preparing an accurate and complete HVAC plan view.

Steps in drawing an HVAC plan

1. On a clean sheet of paper, trace the structural features of the floor plan. Use light linework, as the HVAC linework will be drawn using heavy lines.
2. Locate and draw to scale the central heating and cooling unit(s).
3. Using the proper symbol, locate all air-supply and air-return outlets. Indicate outlet capacities as measured in cfm's.
4. Show all rectangular ductwork, connecting it to the proper air outlets. Draw ductwork to scale and indicate its size with a callout.
5. Show circular ductwork. Draw ductwork to scale and indicate its size with a callout.
6. Indicate all air-return ducts as hidden lines. This helps a reader more readily visualize the system's function and identify components on the plan.
7. Indicate the location of all temperature controls and other system controls (thermostats, humidity controls, air flow, etc.).
8. Complete all notes, callouts, legends, and schedules as required.

STUDENT SUPPLEMENT 1

FIGURE 1


G E MODEL L234-S2 ELECTRIC FURNACE
OUTSIDE VENT
12×24
RETURN AIR
MECH ROOM
G E MODEL GS1401-B RETURN AIR CABINET
Ø6"
Ø12"
RETURN AIR
DAMPER
20×14
20×12
Ø6"
DAMPER
DAMPER
DOWN
RETURN AIR
14×9
20" x 12" 500 CFM TYPICAL
14×9
Ø9"
Ø8"

HVAC SYSTEMS
UNIT 9

ASSIGNMENT SHEET 1—USE STANDARD HVAC SYSTEM-DESIGN HANDBOOKS TO ANSWER QUESTIONS CONCERNING HVAC SYSTEMS

Name ______________________________ Score ______________

Introduction A knowledge of the format and of the information contained in the *Uniform Mechanical Code* and the ASHRAE handbooks is of great importance to a drafter when drawing HVAC plans. In this assignment sheet you will practice using these important sources of information.

Exercise

Directions Review the information presented in Objective 12 of the information sheet. Then, using the handbook indicated in each of the items below, answer the following questions. Write your answers on the blanks provided with each item.

NOTE: The latest editions of each book—the 1988 edition of the UMC and the 1980-82 edition of the ASHRAE volumes—should be used in answering these questions.

1. What subject is discussed in Section 1, Chapter 3, Part 1 of the ASHRAE applications handbook?

   Subject ______________________________

2. In the ASHRAE applications handbook, in what section and chapter would you find information on HVAC design for educational facilities?

   Section ______________ Chapter __________

3. In the ASHRAE applications handbook, where would you find information concerning various codes and standards as provided by societies and associations related to the HVAC design industry?

   Section ______________ Chapter __________

4. Refer to Section 706(c) of the *Uniform Mechanical Code*. What is the minimum total area of return-air ducts required for a gravity-type warm-air furnace?

   Minimum total area ______________________

5. Refer to Section 1102 of the UMC. What type of ducting is used for conveying air at temperatures not to exceed 250 degrees F?

   Type of ducting ______________________

ASSIGNMENT SHEET 1

6. Refer to the ASHRAE fundamentals handbook. Where would you find mathematical equations for duct design?

   Section ______________________ Chapter __________

7. Section 4, Chapter 25 of the ASHRAE fundamentals volume is divided into 5 sections that discuss the calculations of energy used by heating equipment. What are the headings of each of these sections?

   a. ____

   b. ____

   c. ____

   d. ____

   e. ____

HVAC SYSTEMS
UNIT 9

ASSIGNMENT SHEET 2—DEVELOP AN HVAC PLAN

Name ______________________________ Score ______________

Introduction In this assignment sheet, you will develop an HVAC plan for the fire-station project you have been working with in the past several units.

Exercise

Directions Locate and review the floor plan of the fire station you completed in Unit 4, Assignment Sheet 3, and study the guidelines presented in Student Supplement 1 and the HVAC-system specifications presented below. Then, on a separate sheet of vellum, develop an HVAC plan for the fire station. Show both supply-air ducts and return-air ducts, and show all air outlets, including grilles, registers, and diffusers.

HVAC-system specifications

- System type—Forced-air furnace; single unit for heating and cooling
- Energy source—Natural gas
- Air-flow system—Extended plenum

HVAC SYSTEMS
UNIT 9

ASSIGNMENT SHEET 3—DEVELOP EQUIPMENT SCHEDULES

Name ______________________________ Score ______________

Introduction

The preparation of a complete, accurate, and easy-to-read equipment schedule is the responsibility of the drafter. Correctly done, the schedule can save valuable time when a reader is locating information about the HVAC system. In this assignment sheet, you will practice creating equipment schedules for two projects.

Exercises

Part A

Directions

Study the description of the heat-pump system given below. Then, on an 8½" × 11" sheet of paper, prepare a complete and accurate equipment schedule for the heat pump.

Description

A small office building will be supplied with a Lennox brand heat pump to meet its heating and cooling needs. The unit description includes the following items.

- The unit model number is CBP10-51.
- The unit has a heating capacity of 61,400 Btuh's and a cooling capacity of 48,900 Btuh's.
- The total air volume for heating and cooling is 1600 cfm's.
- The unit has a cooling-compressor watts input of 3960 and a heating-compressor watts input of 4495.
- The unit has an energy-efficiency rating (EER) of 8.2 and a coefficient of performance (COP) of 2.9.
- The line-voltage data for the unit is 230v-60hz-1ph.

Part B

Directions

Review the HVAC plan you developed in Assignment Sheet 2. Then make a print of the HVAC drawing to mark up in developing the equipment schedule.

ASSIGNMENT SHEET 3

Using *Sweets Catalog* file and/or *Architectural Graphic Standards*, select all components required to complete the HVAC system that you have drawn. Then prepare schedules for the heating and cooling unit and for the air-supply and air-return outlets. Place the schedules on the HVAC plan where appropriate.

HVAC SYSTEMS
UNIT 9

WRITTEN TEST

Name ______________________________ Score ______________

1. Match terms associated with HVAC systems to their correct definitions. Write the numbers on the blanks provided. Definitions continue on the next page.

______a. Register that emits air flow in a radial or fan-like pattern

______b. Heating system in which heat is transferred from the point of combustion to the air supplied to the system; section of a boiler in which combustion occurs

______c. Surface designed to transfer its heat from a fluid to surrounding air, as in a steam- or water-heat system

______d. Device that transfers heat from steam or hot water to the room air

______e. Closed tank connected to an energy source that heats water to a high temperature

______f. Device used to regulate air flow

______g. Rectangular or cylindrical sheet-metal-enclosed channel through which air is moved in an air-distribution system

______h. Louvered plate usually found in an air-return opening

______i. Duct that is part of the system used to remove air from an enclosed area and discharge it into the atmosphere

______j. Large chamber into which an air-handling system discharges air or returns air

______k. Duct that is part of the system used to vent fresh air into an air-distribution system

1. Boiler
2. Convector
3. Damper
4. Diffuser
5. Duct
6. Exhaust duct
7. Fresh-air duct
8. Furnace
9. Grille
10. Plenum
11. Radiator
12. Register
13. Thermostat

WRITTEN TEST

_______l. Grille that contains a damper to help regulate air flow

_______m. Automatic temperature-sensitive device that opens and closes a circuit to regulate the temperature of an area

2. State definitions of abbreviations commonly used in HVAC design. Write your answers on the blanks provided beside each abbreviation listed below.

   a. Btu ____
   ____
   ____

   b. Btuh ____
   ____
   ____

   c. Cfm ____
   ____
   ____

   d. HTF ____
   ____
   ____

   e. R-value ____
   ____
   ____

3. Define the term *air-conditioning*. Write your answer on the blanks provided beside the term below.

   Air-conditioning ____
   ____
   ____
   ____

WRITTEN TEST

4. List the major subsystems of an HVAC system. Write your answers on the blanks provided below.

a. ____

b. ____

c. ____

5. Match major types of commercial heating systems to their correct descriptions. Write the numbers on the blanks provided.

_____a. System using a furnace to heat the air and fans and a system of supply ducts and branches, registers, and diffusers to circulate the warmed air throughout a structure

_____b. System using a boiler to create steam that is circulated through structure in a system of pipes and then to radiators that warm the air in each room

_____c. System using a solar collector to capture sun's radiation and convert it to heat

_____d. System using an electric heater that produces heat by passing electrical current through resistive wires; heat is then dispersed by means of a fan or transferred to a sealed water supply

_____e. System using a boiler to heat water, a system of flexible tubing and narrow piping to circulate heated water throughout structure, and wall-mounted convectors that force out air heated by circulating hot water

1. Forced-air system
2. Forced-circulation hot-water system
3. Steam-heat system
4. Electric-heat system
5. Solar-heat system

6. Distinguish between definitions of classifications of cooling systems. Write a "CS" in the blank before the definition of a *central system* and a "US" before the definition of a *unitary system.*

_____a. Cooling system that is separate from the heating system and uses its own distribution system

_____b. Cooling system that is an integral part of the heating system and uses the same distribution system

WRITTEN TEST

7. Describe major types of central cooling systems. Write your answers on the blanks provided beside each of the terms below.

   a. Air system ______________________________

   b. Water system ______________________________

   c. Air and water system ______________________________

8. List basic components of a ventilation system. Write your answers on the blanks provided below.

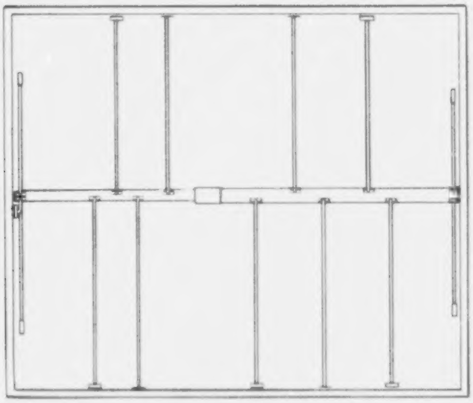
   a. ______________________________

   b. ______________________________

   c. ______________________________

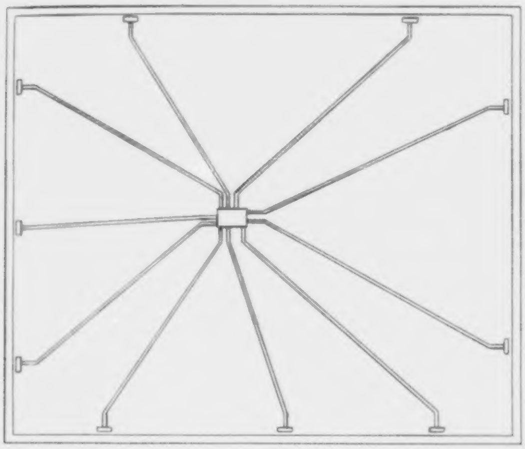
   d. ______________________________

9. Label types of ventilation systems. Write your answers on the blanks provided under each of the illustrations below.



   a. ______________________________

WRITTEN TEST



b. ______________________________

10. Match climatic zones in the 48 adjacent states of the United States to their correct descriptions. Write the numbers on the blanks provided.

______a. Zone with severe and prolonged winters but with summer temperatures that are, on average, higher than those found in Zone A

______b. Zone with mild winters and hot summers

______c. Zone with moderate winters and summers with extended periods of hot days

______d. Zone with severe and prolonged winters and summers that are relatively mild

1. Zone A
2. Zone A-1
3. Zone B
4. Zone C

11. List 6 of the 8 factors used in determining HVAC-system size requirements. Write your answers on the blanks provided below.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

WRITTEN TEST

12. Match standard HVAC system-design handbooks and specification manuals to descriptions of the type of information contained in each book. Write the numbers on the blanks provided.

______a. Discusses HVAC equipment design and energy calculations in six major areas: theory, general engineering data, basic materials, load and energy calculations, duct and pipe sizing, and general applications

______b. Discusses specific types of HVAC systems available and lists performance criteria for each type in four major areas: air-conditioning and heating systems, industrial ventilation systems, refrigeration systems, and general applications

______c. Sets forth guidelines and standards for HVAC-system design in the same format developed for the *Uniform Building Code* and the *Uniform Plumbing Code*; contains five major parts: administrative, definitions and abbreviations, HVAC, refrigeration, and miscellaneous

______d. Discusses HVAC system-design criteria for specific applications in seven major areas: air-conditioning and heating—comfort, air-conditioning and heating—special and process, food refrigeration, distribution of chilled and frozen foods, low-temperature applications, industrial application of refrigeration, and general applications

______e. Set forth HVAC system-design and installation requirements for commercial, residential, and industrial applications

1. *Uniform Mechanical Code*
2. *ASHRAE Handbook—Applications Volume*
3. *ASHRAE Handbook—Fundamentals Volume*
4. *ASHRAE Handbook—Systems Volume*
5. *Air-Conditioning Contractors of America Manuals*

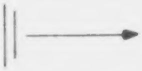
WRITTEN TEST

13. Identify HVAC-system drafting symbols. Write your answers on the blanks provided below each of the following illustrations.

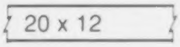
Compressed air
Duct (plan)
Exhaust duct (section)
Supply outlet
Register
Wall supply outlet

Medium-pressure return
Supply duct (section)
Recirculation duct (section)
Radiator
Diffuser (round, ceiling)
Wall return outlet

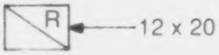
Thermostat
Fresh-air duct (section)
Exhaust inlet
Convector
Furnace
High-pressure steam



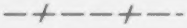
a. ____________________



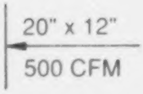
b. ____________________



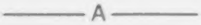
c. ____________________



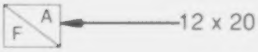
d. ____________________



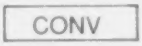
e. ____________________



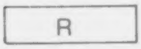
f. ____________________



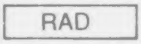
g. ____________________



h. ____________________

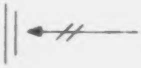


i. ____________________



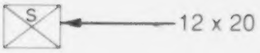
j. ____________________

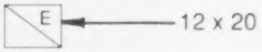
k. ____________________



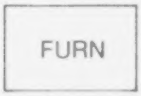
l. ____________________

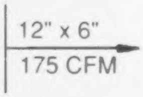
WRITTEN TEST



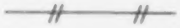


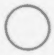
m. ____________________ n. ____________________




12" x 6"
175 CFM

o. ____________________ p. ____________________





q. ____________________ r. ____________________

14. State purposes of types of HVAC equipment schedules. Write your answers on the blanks provided beside each equipment-schedule type listed below.

a. Grille and diffuser schedule ____________________

b. Boiler schedule ____________________

c. Radiator schedule ____________________

d. Unit heater schedule ____________________

ELECTRICAL SYSTEMS
UNIT 10

UNIT OBJECTIVE

After completing this unit, the student should be able to list major subsystems of an electrical system, identify equipment and materials used in electrical systems, label symbols used on electrical-system plans, and state purposes of schedules used in electrical-system plans. The student should also be able to develop an electrical power-distribution plan and an electrical lighting plan. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with electrical systems to their correct definitions.
2. Match units of measure associated with electrical systems to their correct definitions.
3. List the major subsystems of a commercial structure's electrical system.
4. Match equipment and materials used in power-distribution systems to their correct definitions.
5. Match materials used in installing electrical power-distribution systems to their correct definitions.
6. Describe major types of lighting sources.
7. List common types of equipment requiring an electrical service load within commercial structures.
8. Label symbols used on electrical plans.
9. State purposes of the types of drawings commonly completed for a structure's electrical system.
10. List components of an electrical power-distribution plan.
11. List components of an electrical lighting plan.
12. State purposes of types of electrical schedules.
13. Use the *National Electrical Code* to answer questions concerning standards for electrical systems. (Assignment Sheet 1)
14. Complete a lighting-fixture schedule. (Assignment Sheet 2)
15. Develop an electrical power-distribution plan. (Assignment Sheet 3)
16. Develop an electrical lighting plan. (Assignment Sheet 4)

ELECTRICAL SYSTEMS
UNIT 10

SUGGESTED ACTIVITIES

Preparation

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery and Application" section and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.
- Obtain films, videotapes, and other media to supplement instruction of this unit.
- Make transparencies from the transparency masters included in this unit.
- Prepare classroom and lab. Put up posters, charts, and signs; display articles and other references related to the objectives of this unit.

Delivery and Application

Unit introduction

- Provide students with objective sheet. Discuss unit and specific objectives.
- Discuss with students the general planning aspects of an electrical system in commercial construction. Explain that safety is the primary consideration when the electrical system is designed.
- Provide students with information sheet. Discuss information sheet.

Objective 1 Match terms associated with electrical systems to their correct definitions.

- Show examples that illustrate terms and make examples available to students in the classroom.

Objective 2 Match units of measure associated with electrical systems to their correct definitions.

- Read to students the definitions of ampere, volt, ohm, and watt. Help students visualize volts, amperes, and ohms by comparing the flow of electrons through a conductor to the flow of water through a pipe.

SUGGESTED ACTIVITIES

- In order for water to flow through a pipe, it must be pushed along by water pressure. For electrons to flow through a conductor, pressure is also necessary. The pressure that pushes electrons through a conductor is called *voltage*, which is measured in volts, abbreviated *E* or *V*.

- The amount of water flowing past a certain point on a pipe (usually from the end of the pipe) can be measured in gallons per minute. Likewise, the number of electrons flowing past a certain point per second can be measured in *amperes*, abbreviated *amps*, *A*, or *I*.

- Just as the diameter of a pipe creates resistance to the water flowing through it—a small pipe producing more resistance than a larger one—a smaller conductor of a given material produces more resistance to electrons flowing through it than does a larger one. And also, the longer the conductor, the greater the resistance it produces. Resistance is measured in *ohms*, abbreviated Ω or *R*.

Objective 3 List the major subsystems of a commercial structure's electrical system.

- List for students the three major subsystems—incoming electrical service, switchgear room, and electrical-distribution system, and then discuss the functions of each subsystem. Use Transparencies 1 and 2 to illustrate your discussion. Use Transparency 1 to discuss the incoming electrical service and its hook-up to the switchgear room and the master service panel. Use Transparency 2 to discuss the components of the electrical-distribution system, including feeder wiring, circuit-breaker panels, and the master service (distribution) panel.

- Explain how many building functions (i.e., ventilation, cooling, heating, lighting, etc.) rely on the proper operation of the electrical distribution system.

Objective 4 Match equipment and materials used in power-distribution systems to their correct definitions.

- Discuss with students the definitions presented in the objective. Use the artwork in the information sheet and Transparency 3, "Equipment and Materials Used in Power-Distribution Systems," to illustrate your discussion.

Objective 5 Match materials used in installing electrical power-distribution systems to their correct definitions.

SUGGESTED ACTIVITIES

- Discuss with students the various materials presented in the objective. Use Transparencies 4, 5, and 6 and the artwork in the objective to illustrate your discussion.
- Show examples of as many of the various materials defined as possible.

Objective 6 Describe major types of lighting sources.

- Read to students the note introducing the objective and the descriptions presented in the information sheet. Then further explain the characteristics of fluorescent lighting, incandescent lighting, and high-intensity discharge (HID) lighting.
- Have students obtain permission to access a commercial building (office, store, business). Have them visit the building and make a list of the types of lighting being used. Have the class discuss what lighting types they found and how the lighting applications could be improved.

Objective 7 List common types of equipment requiring an electrical service load within commercial structures.

- Explain that a vast number of building systems require an electrical service load. Go over the list presented in the information sheet.
- Have students name as many different electrical service loads as they can think of that appear in their school building. Then take the students on a tour of the school's various facilities, including the mechanical room(s), cafeteria, telephone-equipment room, etc.

Objective 8 Label symbols used on electrical plans.

- Discuss the symbols presented in the objective, using Transparency 7, "Symbols Used on Electrical Plans," to illustrate your discussion.
- Draw on the chalkboard each of the symbols presented. Explain the meaning of each symbol and provide an application of where the symbol would be found on an actual drawing.

Objective 9 State purposes of the types of drawings commonly completed for a structure's electrical system.

Objective 10 List components of an electrical power-distribution plan.

SUGGESTED ACTIVITIES

Objective 11 List components of an electrical lighting plan.

- Discuss with students the purposes of electrical power-distribution plans and electrical lighting plans. Use Transparencies 8 and 9 to illustrate your discussion.

- Discuss with students the components of an electrical power-distribution plan, as presented in Objective 10. Provide examples of commercial plans. Discuss the symbols, schedules, and notes shown on the plans.

- Discuss with students the components of an electrical lighting plan, as presented in Objective 11. Provide examples of commercial plans, including a reflected ceiling plan. Discuss the symbols, schedules, and notes shown on the plans. Show students how indications are made to show which switch connects to which light fixtures.

Objective 12 State purposes of types of electrical schedules.

- Explain the common types of electrical schedules presented in the objective, using Transparencies 10, 11, and 12 and the tables in the objective to illustrate your explanation.

- Discuss each of the components that make up a given type of schedule.

Assignment Sheet 1 Use the *National Electrical Code* to answer questions concerning standards for electrical systems.

- Hand out Student Supplement 1, "Guidelines for Using the National Electrical Code," and Assignment Sheet 1. Also distribute a copy of the NEC to the class. Explain the reasons the handbook was developed by the National Fire Protection Association and discuss the book's format. Provide sample questions or topics for the students to look up in the handbook.

- Discuss the directions to the exercise in the assignment sheet. Answer any student questions and then have students complete Assignment Sheet 1.

Assignment Sheet 2 Complete a lighting-fixture schedule.

- Hand out the assignment sheet and discuss the introduction and directions to the exercise. Take time to explain the scenario presented in the directions to the exercise. Then answer any student questions and have students complete Assignment Sheet 2.

Assignment Sheet 3 Develop an electrical power-distribution plan.

SUGGESTED ACTIVITIES

Assignment Sheet 4 Develop an electrical lighting plan.

- Have students locate the floor plan of the fire station they developed in Unit 4, Assignment Sheet 3. Then read with students the specifications for the plans presented in the directions to each of the assignment sheets. Answer any student questions and have students complete Assignment Sheets 3 and 4.

Evaluation

- Give written test.
- Compile written-test and assignment-sheet scores on Unit Evaluation Form.
- Reteach and retest as required.

Suggested Resources

Resources used in developing unit

Print media

- Callendar, John. *Time Saver Standards for Architectural Design Data*, 6th ed. New York: McGraw-Hill, 1982.
- Harris, Cyril M. *Dictionary of Architecture and Construction.* New York: McGraw-Hill, 1975.
- Hettema, Robert M. *Mechanical and Electrical Building Construction.* Englewood Cliffs, New Jersey: Prentice-Hall, 1984.
- *National Electrical Code.* Quincy, Massachusetts: National Fire Protection Association, 1987.

Resources to be used as student references

NOTE: The reference listed below will be required by students in completing Assignment Sheet 1, "Use the *National Electrical Code* to Answer Questions Concerning Standards for Electrical Systems."

- *National Electrical Code.* Quincy, Massachusetts: National Fire Protection Association, 1987.

Additional resources

Print media

- Muller, Edward J. *Architectural Drawing and Light Construction.* Englewood Cliffs, New Jersey: Prentice-Hall, 1985.

SUGGESTED ACTIVITIES

- Putnam, Robert E. *Building Trades Blueprint Reading.* Reston, Virginia: Reston Publishing Company, Inc., 1986.
- Ramsey, Charles. *Architectural Graphic Standards*, 8th ed. New York: Wiley and Sons, 1988.

ELECTRICAL SYSTEMS
UNIT 10

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

1. Use and identification of grounded conductors
2. Chapter 1, article 100
3. Article 670
4. Chapter 5, article 513
5. 10′-0″

Assignment Sheet 2

EVALUATOR'S NOTE: The lighting-fixture schedule should be in chart form with appropriate headings, and should include the information in the following table.

Quantity	Manuf	Model	Type	Description
6	Metalux Co.	MC-442A	AH4	2′ × 4′ fluorescent
4	Metalux Co.	MC-22B	AH1	2′ × 2′ fluorescent
2	Halo, Inc.	H5510	ID6	Square, wall-mounted incandescent
10	Halo, Inc.	H5700	ID8	Square, wall-mounted incandescent
11	Spectrum Co.	S-23A	IS4	Square, wall-mounted incandescent
6	H & H, Inc.	HX-13	ET	Emergency light
5	BASCO, Inc.	4TS-2215	FL-2	Two-head floodlight

Assignment Sheet 3

Evaluated to the satisfaction of the instructor.

Assignment Sheet 4

Evaluated to the satisfaction of the instructor.

ELECTRICAL SYSTEMS
UNIT 10

ANSWERS TO WRITTEN TEST

1. a. 8
   b. 9
   c. 2
   d. 4
   e. 10
   f. 5
   g. 7
   h. 1
   i. 6
   j. 3
   k. 13
   l. 11
   m. 14
   n. 12
   o. 15
   p. 19
   q. 16
   r. 17
   s. 18

2. a. 2
   b. 3
   c. 4
   d. 1

3. a. Incoming electrical service
   b. Switchgear room
   c. Electrical-distribution system

4. a. 3
   b. 5
   c. 6
   d. 2
   e. 4
   f. 1

5. a. 1
   b. 3
   c. 2
   d. 4
   e. 5

6. a. Light source in which a phosphor coating transforms ultraviolet energy, produced by a discharge, into light; provides a general-use, diffuse light
   b. Light source in which a tungsten filament is heated to the point of illumination by an electrical current; provides a focused, direct light source
   c. Gas-discharge light source utilizing mercury, sodium, or metal halide gas; provides an intense light in lamp-type form

7. Answer should include any 6 of the following

   a. Lighting
   b. Office equipment
   c. Data-processing equipment
   d. Heating, ventilating, and air-conditioning equipment
   e. Electric kitchen equipment
   f. Telephone equipment
   g. Fire-alarm equipment
   h. Miscellaneous equipment

ANSWERS TO WRITTEN TEST

8. a. Duplex receptacle outlet
b. Electric motor
c. Fire detector
d. Single-pole switch
e. 220-volt outlet
f. Master power-service panel
g. Lighting outlet
h. Low-voltage wire
i. Low-voltage switch
j. Weather-protected duplex outlet
k. Fluorescent-light troffer
l. Junction box
m. Floor outlet
n. GFI circuit
o. Special-purpose outlet
p. Split-wire receptacle outlet
q. Fire-alarm control panel
r. Three-way switch
s. Manual fire-alarm box
t. Lighting-distribution panel
u. Motor outlet
v. Fire bell
w. Telephone outlet

9. a. Shows the location and distribution of all power sources in a structure, excluding lighting
b. Shows the location of lighting-system components and information relating to those components

10. Answer should include any 7 of the following

a. Location and labeling information of the master service panel
b. Location of all convenience outlets
c. Location of components of the fire-alarm system
d. Location of components of the security system
e. Location of components of the telephone system
f. Location of power sources for all mechanical equipment
g. Location of all circuit breakers
h. Location of all branch power panels
i. Necessary electrical schedules, legends, and notes
j. Conduit size
k. Conductor size

11. Answer should include any 4 of the following

a. Location of all light switches
b. Location of all lighting fixtures and indications of which switch each fixture is connected to
c. Location of all lighting-panel boxes and indications that identify which structural area is controlled by each panel box
d. Reflected ceiling plan
e. Lighting-fixture schedule
f. Necessary legends and notes

12. a. Provides a listing of the electrical circuits leading from the main service panel and contains necessary technical information for service hook-up and installation

ANSWERS TO WRITTEN TEST

b. Supplies information about individual light fixtures, including manufacturer, model number, fixture type, quantity, and a description

c. Provides electrical-load data and circuit information about each piece of equipment requiring electrical power

ELECTRICAL SYSTEMS
UNIT 10

UNIT EVALUATION FORM

Student name ______________________________ Unit rating __________

Assignment sheet ratings

Assignment Sheet 1—Use the *National Electrical Code* to Answer Questions Concerning Standards for Electrical Systems Rating __________

Comments: ______________________________

____

Assignment Sheet 2—Complete a Lighting-Fixture Schedule Rating __________

Comments: ______________________________

____

Assignment Sheet 3—Develop an Electrical Power-Distribution Plan Rating __________

Comments: ______________________________

____

Assignment Sheet 4—Develop an Electrical Lighting Plan Rating __________

Comments: ______________________________

____

Written test scores

Pretest __________ Other __________

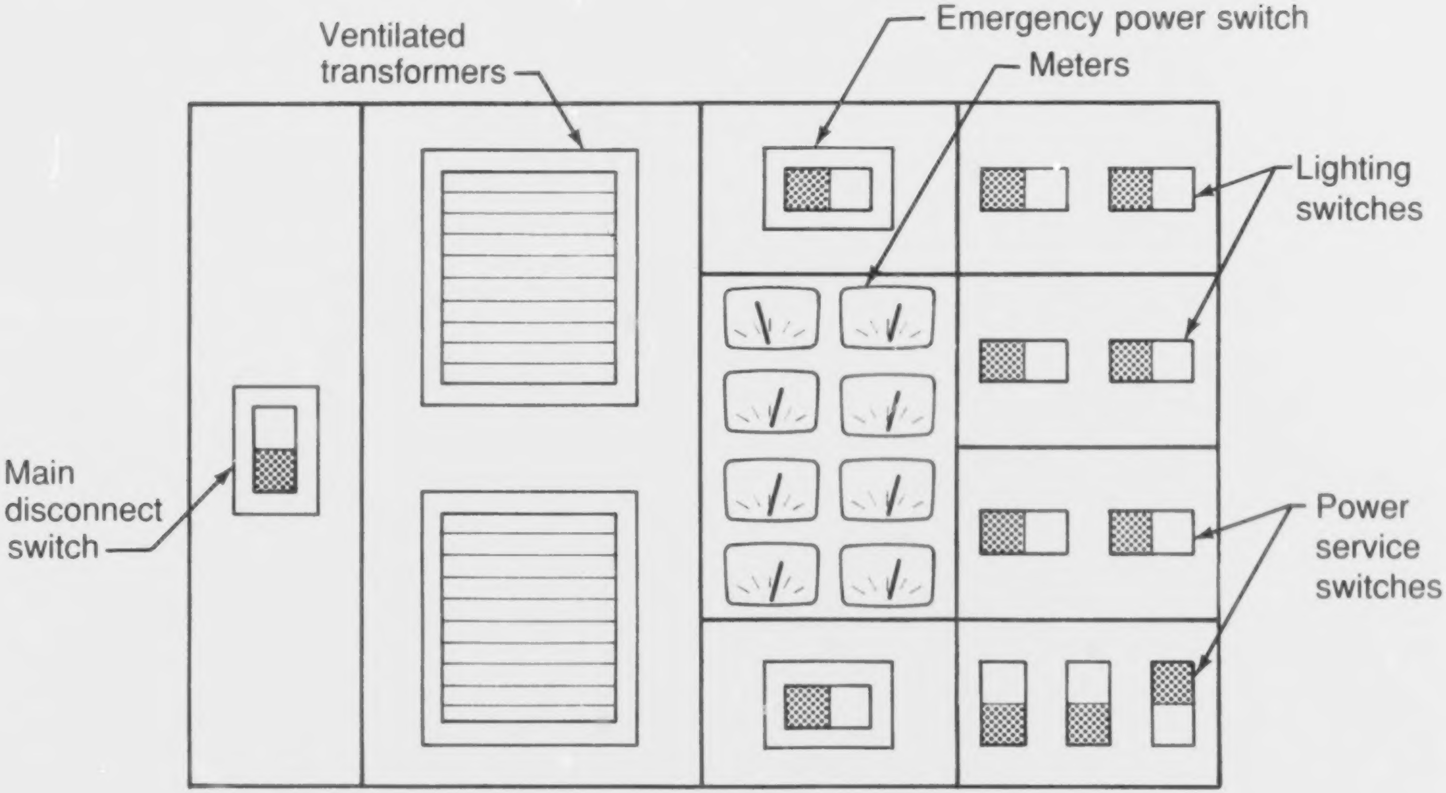
Posttest __________

Instructor signature ______________________________ Date __________

Student signature ______________________________ Date __________

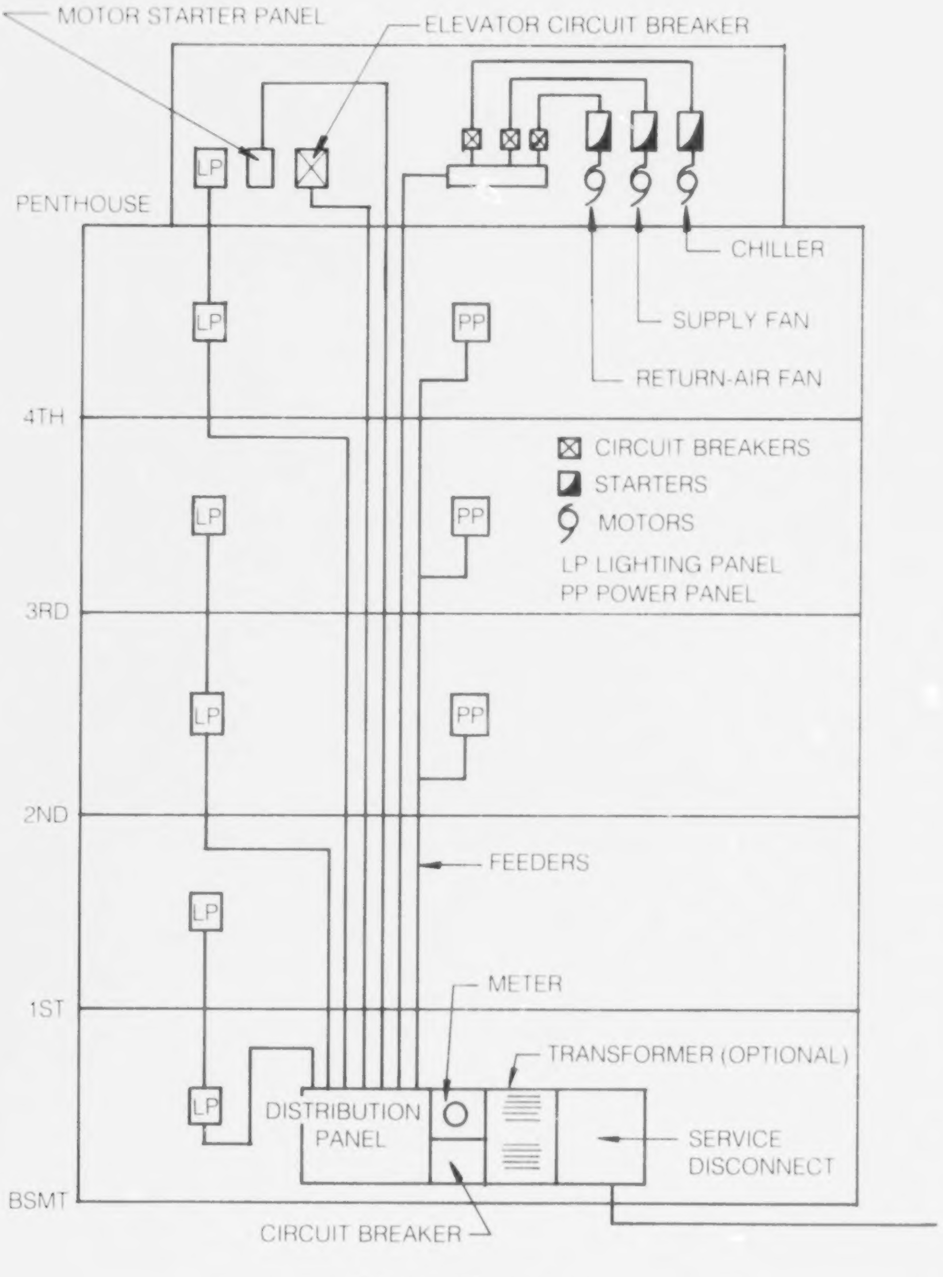
Duplication of this form is permitted.

Electrical Switchgear Layout*


Ventilated transformers
Emergency power switch
Meters
Lighting switches
Main disconnect switch
Power service switches

*Switchgear layouts vary with building function.

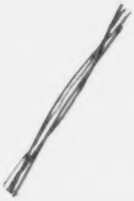
Electrical-Distribution System


MOTOR STARTER PANEL
ELEVATOR CIRCUIT BREAKER
PENTHOUSE
LP
CHILLER
PP
SUPPLY FAN
RETURN-AIR FAN
4TH
CIRCUIT BREAKERS
STARTERS
MOTORS
LP LIGHTING PANEL
PP POWER PANEL
3RD
2ND
FEEDERS
1ST
METER
TRANSFORMER (OPTIONAL)
DISTRIBUTION PANEL
SERVICE DISCONNECT
BSMT
CIRCUIT BREAKER

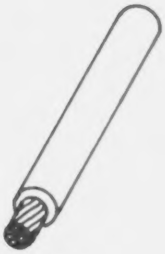
Riser diagram

Used with permission of Robert M. Hettema from *Mechanical and Electrical Building Construction* by Robert M. Hettema, copyright 1984.

Equipment and Materials Used in Power-Distribution Systems

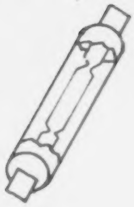


Wire
(strands)

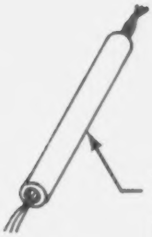


Cable

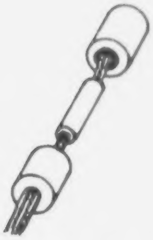
Conductors



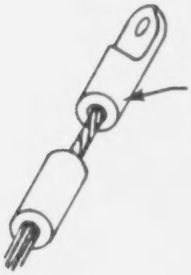
Fuse


Insulating
material

Insulator



Connector

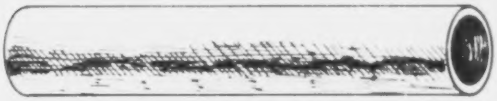

Terminal
lug

Terminal

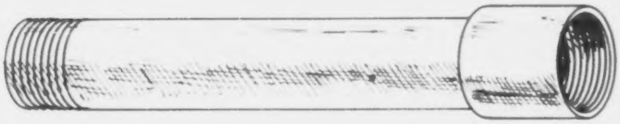
Connectors

Materials Used in Installing Electrical Power-Distribution Systems

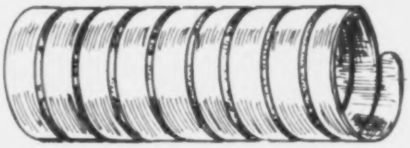
Conduit



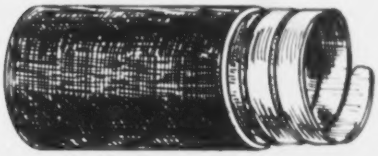
Electrical metallic conduit



Rigid-metal conduit and coupling



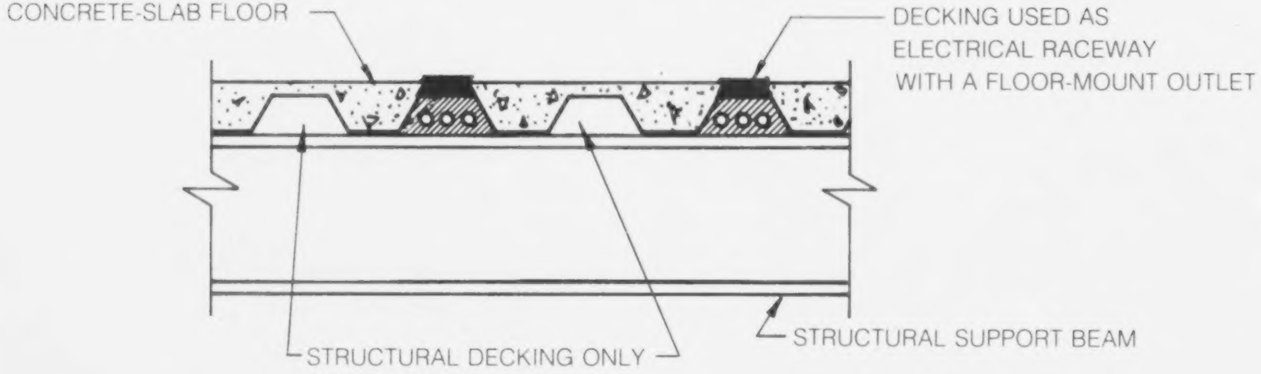
Flexible-metal conduit



Liquid-tight flexible-metal conduit

PVC conduit (rigid or flexible)

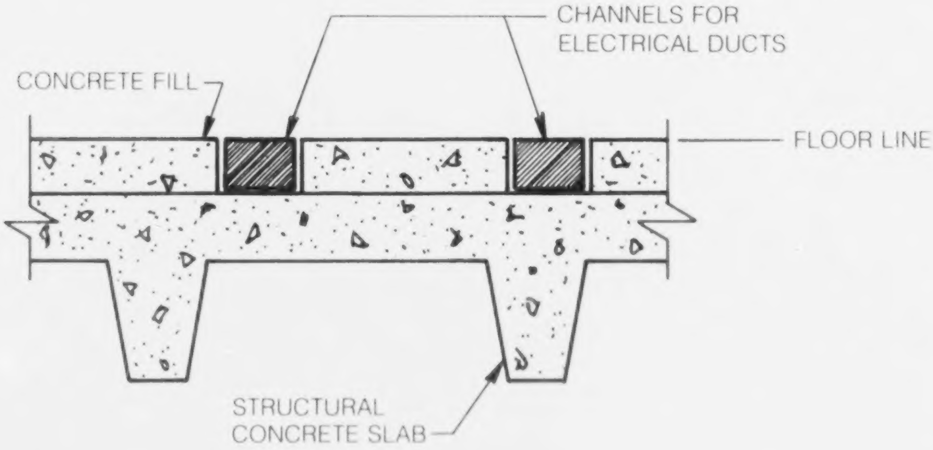
Materials Used in Installing Electrical Power-Distribution Systems
(Continued)


CONCRETE-SLAB FLOOR
DECKING USED AS ELECTRICAL RACEWAY WITH A FLOOR-MOUNT OUTLET
STRUCTURAL DECKING ONLY
STRUCTURAL SUPPORT BEAM

Cellular decking

Materials Used in Installing Electrical Power-Distribution Systems

(Continued)

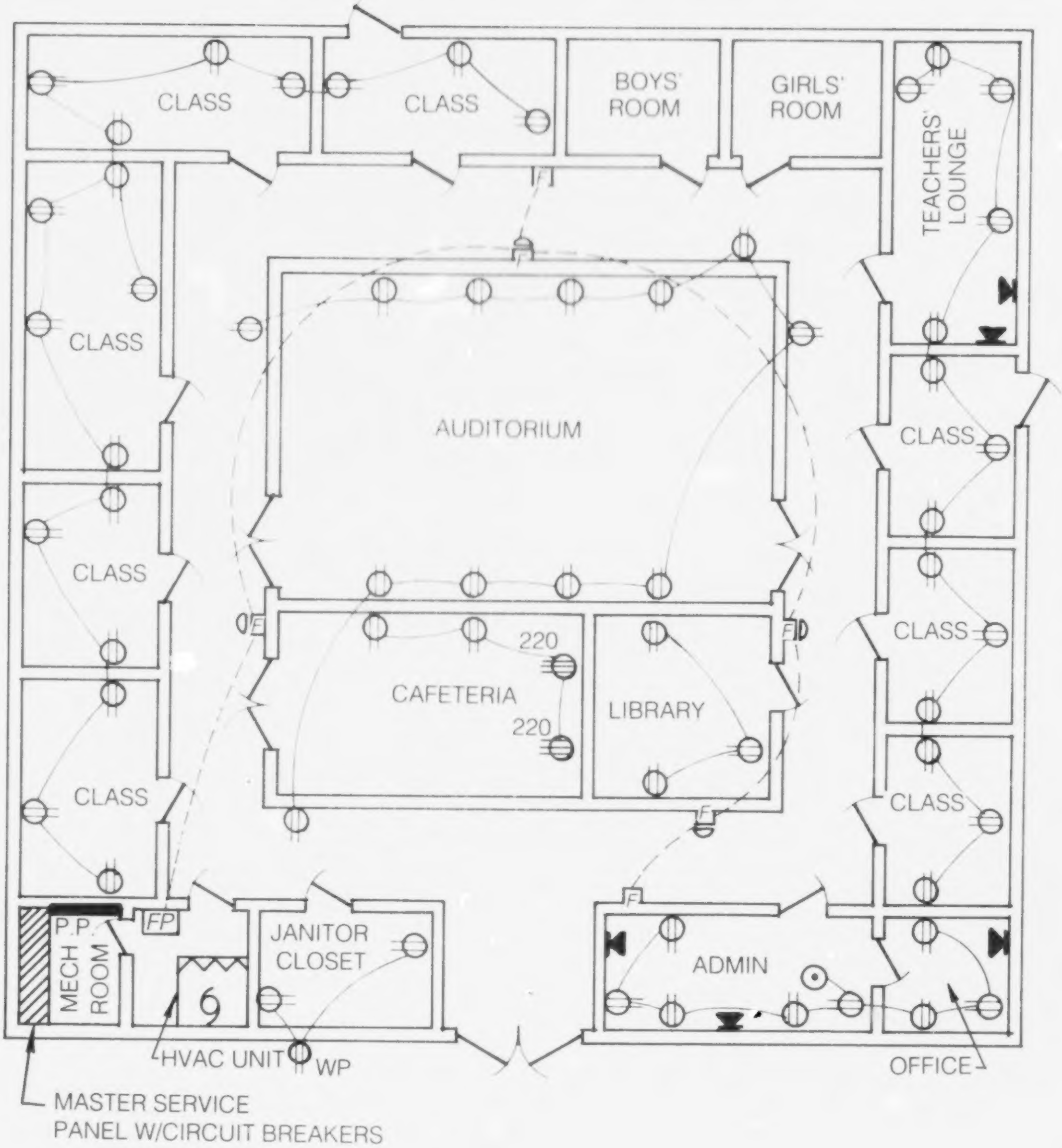

CHANNELS FOR ELECTRICAL DUCTS
CONCRETE FILL
FLOOR LINE
STRUCTURAL CONCRETE SLAB

Channels

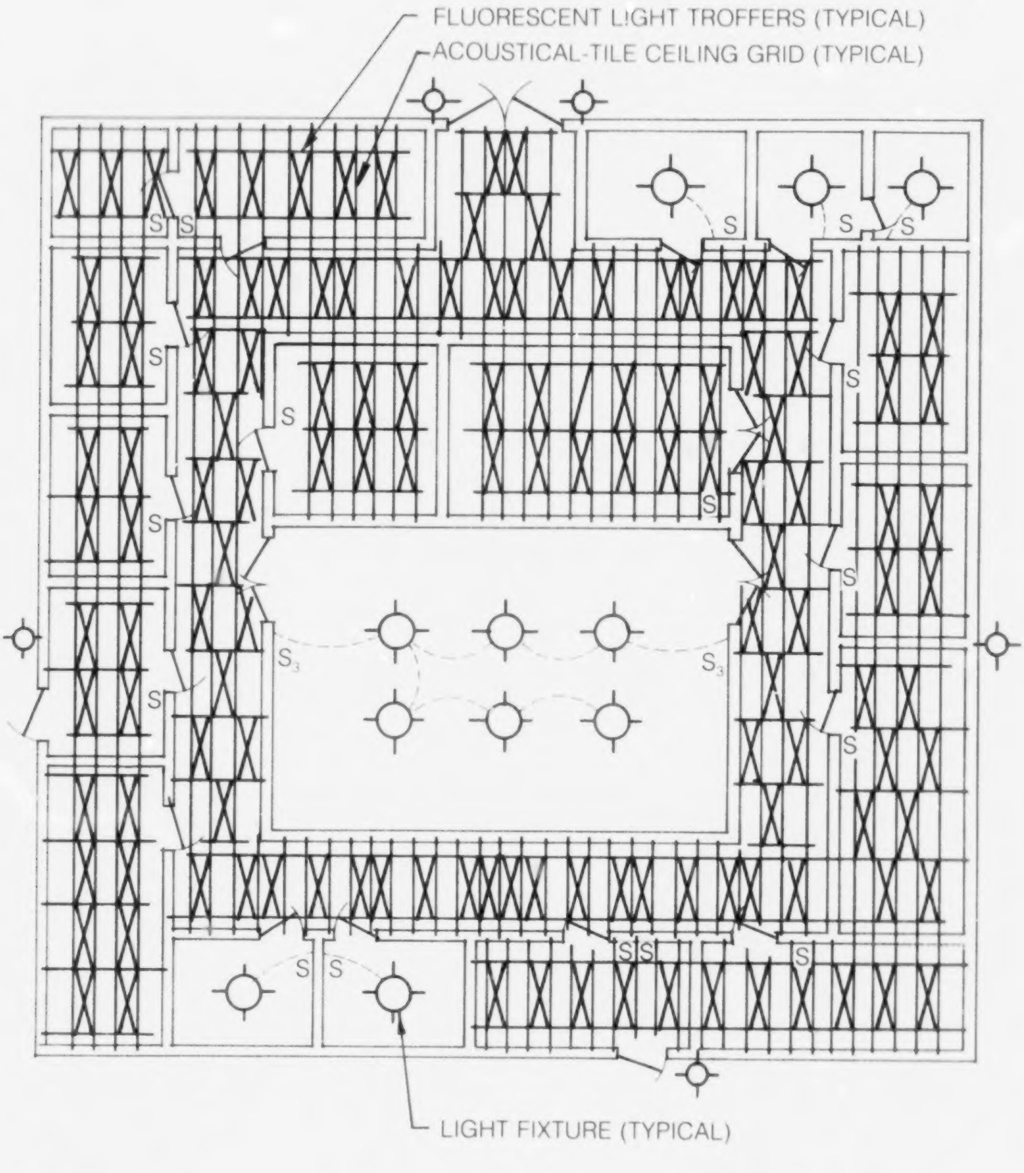
Symbols Used on Electrical Plans

Component name	Symbol	Component name	Symbol
Single-pole switch	S	Lighting outlet	⌖
Three-way switch	S_3	Motor outlet	Ⓜ
Low-voltage switch	$\underline{S}$	Master power-service panel	▨
Low-voltage wire	——— - - ———	Lighting-distribution panel	▮
GFI circuit	⊜ GFI	Telephone outlet	◀
Duplex receptacle outlet	⊜	Fluorescent-light troffer	⊠
Split-wire receptacle outlet	⊜	Fire detector	Ⓕ
Weather-protected duplex outlet	⊜ WP	Manual fire-alarm box	$\boxed{F}$
220-volt outlet	⊜ 220	Fire bell	$\boxed{F}$
Floor outlet	⊙	Fire-alarm control panel	$\boxed{FP}$
Special-purpose outlet	▲	Electric motor	6
Junction box	Ⓙ		

Electrical Power-Distribution Plan


CLASS
CLASS
BOYS' ROOM
GIRLS' ROOM
TEACHERS' LOUNGE
F
CLASS
AUDITORIUM
CLASS
CLASS
CLASS
F
F
220
CAFETERIA
220
LIBRARY
CLASS
CLASS
F
F
P.P.
FP
MECH ROOM
JANITOR CLOSET
ADMIN
HVAC UNIT
WP
OFFICE
MASTER SERVICE PANEL W/CIRCUIT BREAKERS

Electrical Lighting Plan


FLUORESCENT LIGHT TROFFERS (TYPICAL)
ACOUSTICAL-TILE CEILING GRID (TYPICAL)
S
S_3
LIGHT FIXTURE (TYPICAL)

Electrical-Distribution Schedule

Circuit number	Location serving	Elec load	Branch breaker size	Wire size	Conduit size
Panel #1	Master switch	400 KW	—	—	—
Panel #2	Lighting panel	110 KW	300 AMP	4/#0	4½″
Panel #3	Water heater	40 KW	215 AMP	3/#4	2¼″
Panel #4	HVAC equipment	132 KW	300 AMP	3/#4	2¼″
Panel #5	Cafeteria appliances	25 KW	150 AMP	3/#2	2″

Lighting-Fixture Schedule

Ref	Manuf	Model number	Fixture type	Quantity	Description
A	GE	4907A	ID3	18	Incandescent downlight
B	GE	4907B	ID4	18	Incandescent downlight
C	Phillips	5310-2	VT	12	Mercury vapor w/reflector
D	Day-brite	DB2-2	AH2	8	1′×4′ recessed flourescent
E	Day-brite	DB2-4	AH4	42	2′×4′ recessed flourescent
F	Lite Co.	F442	AH44	5	4′×4′ recessed flourescent

Electrical Load and Circuit Schedule

Equipment name	Watts	Volts	Wires	Circuit breaker	Type of outlet	Notes
Heat pump motor	8000	120/240	2/#4	80 AMP	Tandem grounding	Direct-connected
Water heating plant motor	22000	120/240	2/#2	80 AMP	Parallel grounding	Direct-connected
Air cooling unit/mech room	9000	120/240	2/#8	45 AMP	Special purpose	Direct-connected
Refrigeration unit/cafeteria	6000	120/240	3/#6	30 AMP	Parallel grounding	Separate circuit
Fryer unit—cafeteria	12000	120/240	3/#6	50 AMP	Special purpose	Separate circuit

ELECTRICAL SYSTEMS
UNIT 10

INFORMATION SHEET

1. **Terms and definitions associated with electrical systems**

   a. **American wire gage** (AWG)—Standard designation for wire of electrical conductors; the higher the designated number, the smaller the diameter of the wire

   b. **Branch circuit**—Circuit that is a subdivision of main feeder circuit; usually serves a specific location or function

   c. **Circuit**—Completed path (loop) for electrical current to flow from source to destination and then back to source

   d. **Conductor**—Material that permits a flow of electricity (electrons)

   e. **Conduit**—Passageway for electrical wiring or cabling

   f. **Current**—Movement or flow of electricity through a conductor

   g. **Electrical-distribution panel** (switchgear)—Enclosure that houses the main power source for a structure's electrical system

   h. **Feeder circuits**—Wiring that runs from switchgear-room circuits to various electrical services throughout structure

   i. **Junction box**—Container that protects conductor splices and provides support for electrical connections; designed to allow conductors to enter through knockouts in the sides and back

   j. ***National Electrical Code***—Handbook published by the National Fire Protection Association; sets forth minimum safety guidelines for electrical systems

   k. **Open circuit**—Incomplete electrical circuit not allowing the flow of electricity

   l. **Outlet**—Destination point in wiring system at which the current can supply equipment requiring an electrical load

   m. **Raceway**—Enclosed channel for routing and placing electrical conductors and cables

   n. **Resistance**—Opposition offered by a substance to the passage of a steady electric current

   o. **Riser diagram**—Schematic drawing showing the floor-to-floor layout of electrical connections, conduit, circuit breakers, and other electrical equipment

   p. **Short circuit**—Connection of comparatively low resistance accidentally made between points on a circuit between which the resistance is normally much greater

INFORMATION SHEET

q. **Switch**—Electrical device used to open or close a circuit

r. **Transformer**—Device designed to increase or decrease voltage or current of an alternating-current circuit

s. **Troffer**—Long, recessed light fixture with opening flush with ceiling

2. **Units of measure associated with electrical systems and their definitions**

a. **Ampere** (amp, A, or I)—Measure of the intensity of electric current; rate at which 1 volt of electricity flows through a conductor with 1 ohm of resistance

b. **Volt** (V or E)—Measure of electrical pressure; equal to the electrical force applied to move the current of 1 ampere over a resistance of 1 ohm

c. **Ohm** (Ω or R)—Measure of electrical resistance; equal to the resistance encountered when 1 ampere of current is driven by 1 volt

d. **Watt**—Measure of electrical power equal to amps multiplied by volts; equal to 1 ampere of current flowing with an electromotive force of 1 volt

NOTE: A kilowatt is 1000 watts.

3. **Major subsystems of a commercial structure's electrical system**

a. **Incoming electrical service**

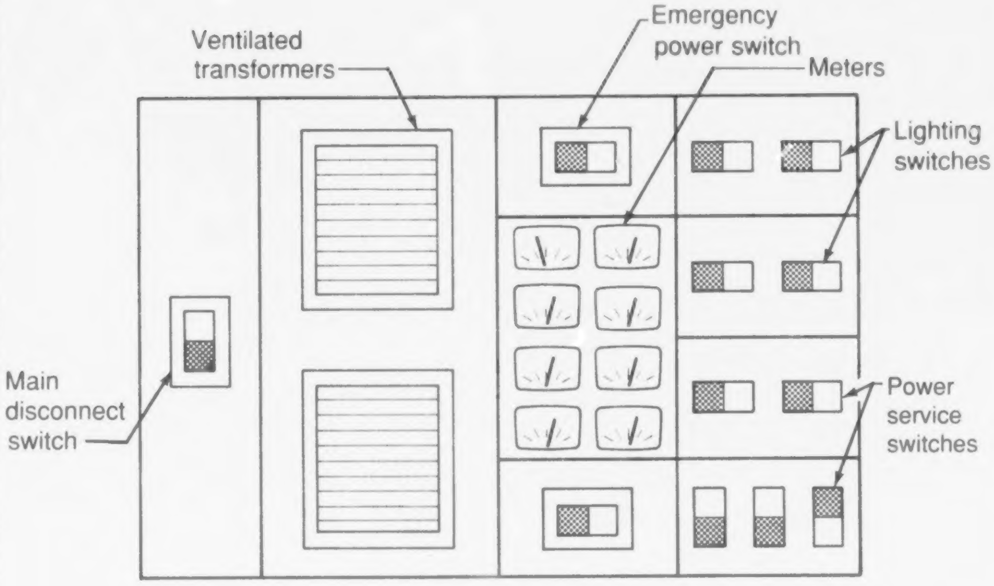
NOTE: The local utility company provides incoming electrical service to a construction site. This service usually consists of the following components: (1) transformer to drop line voltage, (2) switching system controlled by the utility company, (3) service entrance—overhead or underground conductors that bring electrical service from utility pole into structure's electrical-distribution panel.

b. **Switchgear room**

NOTE: The switchgear room is the main electrical servicing and access location for a structure. The following equipment is located in the switchgear room: (1) electrical-distribution panel, (2) switching system controlled by the utility customer, (3) transforming equipment, (4) metering equipment, (5) circuit breakers and fuses, (6) emergency power source. Figure 1 shows a typical electrical-distribution-panel layout in a switchgear room.

INFORMATION SHEET

FIGURE 1: Electrical-distribution-panel layout


Ventilated transformers
Emergency power switch
Meters
Lighting switches
Main disconnect switch
Power service switches

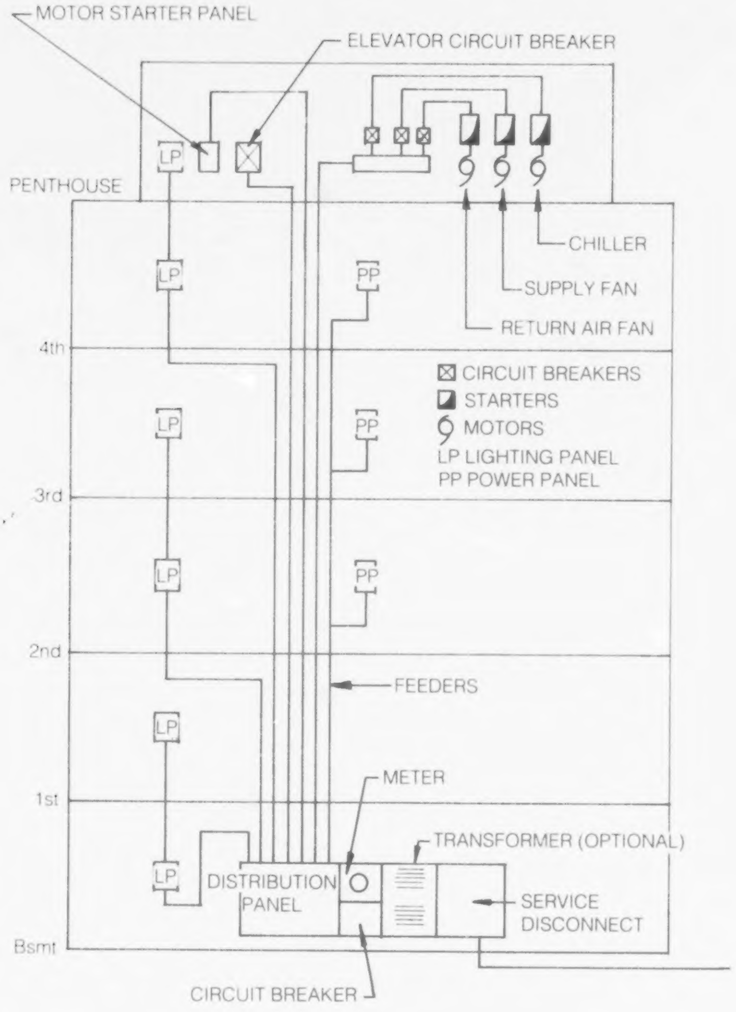
*Switchgear layouts vary with building function.

c. **Electrical-distribution system** (see Figure 2)

NOTE: The electrical-distribution system consists of wiring (called *feeders*, *feeder wires*, or *feeder circuits*) that run from the switchgear room to the various services that require electrical power (i.e., lighting, HVAC system, electrical outlets, equipment motors). Each feeder wire is dedicated to a single service and will be connected to its own circuit breaker and manual shut-off switch. Feeders are normally enclosed and run under floors, over ceilings, and through walls in order to provide service at the required locations.

INFORMATION SHEET

FIGURE 2: Electrical-distribution system


MOTOR STARTER PANEL
ELEVATOR CIRCUIT BREAKER
LP
PENTHOUSE
CHILLER
SUPPLY FAN
RETURN AIR FAN
LP
PP
4th
☒ CIRCUIT BREAKERS
◪ STARTERS
9 MOTORS
LP LIGHTING PANEL
PP POWER PANEL
LP
PP
3rd
LP
PP
2nd
FEEDERS
LP
1st
METER
TRANSFORMER (OPTIONAL)
LP
DISTRIBUTION PANEL
SERVICE DISCONNECT
Bsmt
CIRCUIT BREAKER

Riser diagram

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INFORMATION SHEET

4. Equipment and materials used in power-distribution systems and their definitions

NOTE: The materials and equipment used in an electrical power-distribution system are vital to the overall performance of the system. The materials and equipment must possess certain characteristics in order to function properly: conductivity, insulating property, thermal resistance, moisture resistance, etc. Discussed below are some of the materials and equipment most commonly used in an electrical system.

a. **Wires** (see Figure 3-a)—Single-conductor wiring no larger in size than no. 8 AWG

NOTE: Common applications for single-conductor wiring are security systems, telephone systems, thermostat circuits, intercom systems, and other low-voltage applications.

b. **Cables** (Figure 3-b)—Single-conductor wiring larger in size than no. 6 AWG, or two or more combined-conductor wiring of any size

NOTE: Cable is commonly used in commercial structures because of the larger voltages required in many applications.

FIGURE 3

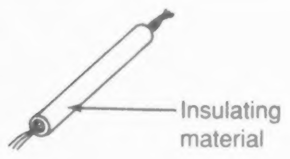
(a) Wire

(b) Cable

c. **Insulators** (Figure 4)—Materials that do not permit the free flow of electricity

NOTE: Wiring and cables (conductors) and other electrical equipment are normally covered with insulating material (insulators). Insulators are made from various materials selected according to the conditions they will be exposed to—heat, cold, moisture, dryness, voltage levels, etc. The *National Electrical Code* (NEC) specifies the type of insulating material (i.e., rubber, thermoplastic, synthetic polymer) that has been approved for a specific application.

FIGURE 4



INFORMATION SHEET

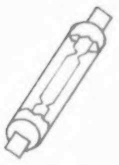
d. **Fuses** (see Figure 5-a)—Tubes containing a soft-metal conductor; designed so that soft-metal conductor melts (burns out) and permanently opens circuit when excessive current flows through it

NOTE: Fuses are circuit-protection devices designed to protect electrical-circuit components from damage in case a short develops in the circuit. If a short should occur, excessive amounts of current flow through the circuit—amounts that could damage or even destroy circuit components. Protection devices are designed to create an open in the circuit to stop current flow and prevent component damage. To close the circuit, a burned-out fuse must be replaced after the short has been eliminated from the circuit.

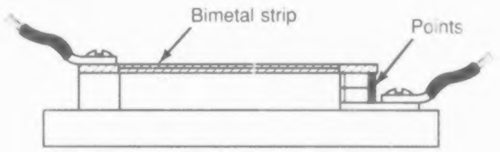
e. **Circuit breakers** (Figure 5-b and -c)—Electro-mechanical devices containing a bimetal strip and a set of points; designed so that when excessive current flows through it, bimetal strip bends away from contact points and temporarily opens circuit until strip cools and again touches contact points

NOTE: Circuit breakers are also circuit-protection devices. However, unlike fuses, circuit breakers do not burn out when there is a short in the circuit. Therefore, it is not necessary to replace a circuit breaker after the short has been eliminated from the circuit. Circuit breakers are used extensively in commercial and industrial applications.

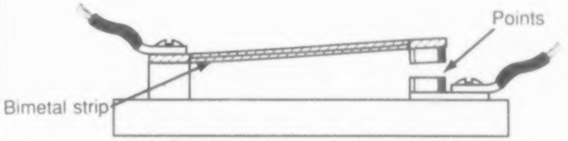
FIGURE 5



(a) Fuse



(b) Circuit breaker carries normal current; bimetal strip contacts points. Circuit is closed.



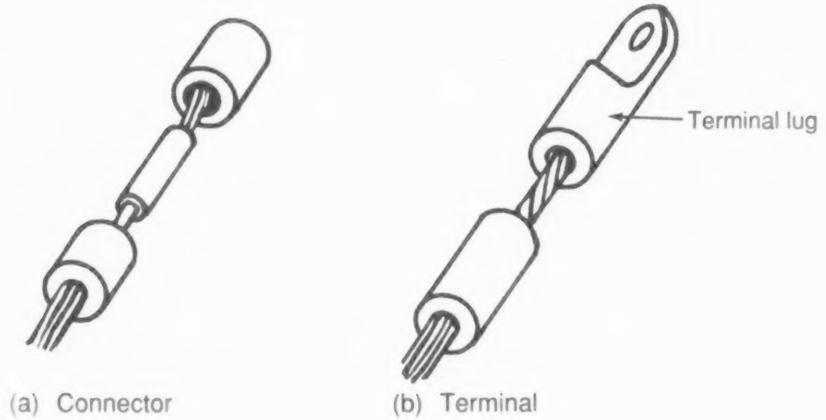
(c) Circuit breaker carries excessive current; bimetal strip bends away from points. Circuit is open.

INFORMATION SHEET

f. **Connectors and terminals** (Figure 6)—Devices attached to the ends of two or more conductors or cables to allow connection of electric current without permanent splices

NOTE: Connectors and terminals are used to ensure that connected conductors or cables do not separate due to vibration, expansion, or contraction. Common connections are wire-to-wire, cable-to-cable, wire/cable-to-source (destination).

FIGURE 6



(a) Connector (b) Terminal

5. Materials used in installing electrical power-distribution systems and their definitions

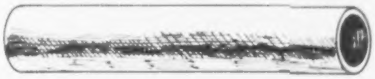
NOTE: Several types of materials are used in creating systems for installing electrical distribution systems in commercial structures. The materials most often utilized are listed below.

a. **Conduit** (see Figure 7)—Structurally supportive hollow galvanized-steel or polyvinyl-chloride (PVC) tubing in which wiring and cabling are run

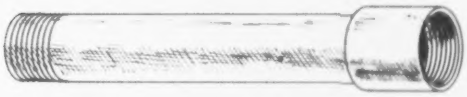
NOTE: Conduit is used in the vast majority of the electrical systems installed in commercial and industrial structures. Conduit is so popular because it is manufactured in almost any size required, because it can be run under floors, in walls, in ceilings, and through poured concrete, and because it can be bent to allow electrical wiring to reach almost any desired location.

INFORMATION SHEET

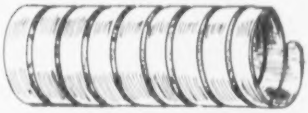
FIGURE 7: Conduit



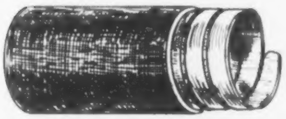
Electrical metallic conduit



Rigid-metal conduit and coupling



Flexible-metal conduit



Liquid-tight flexible-metal conduit

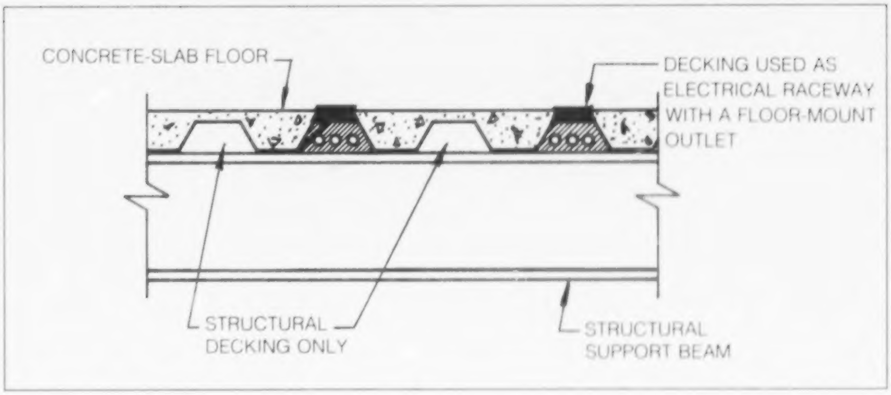
PVC conduit

b. **Cellular decking** (see Figure 8)—Light-gage metal sheets with channels used to form electrical raceways for running wiring, cabling, or conduit

NOTE: Cellular decking is used in high-quality commercial construction to allow for electrical outlets to be mounted flush with the floor in numerous locations, eliminating the need for columns or power poles extending from floor to ceiling.

INFORMATION SHEET

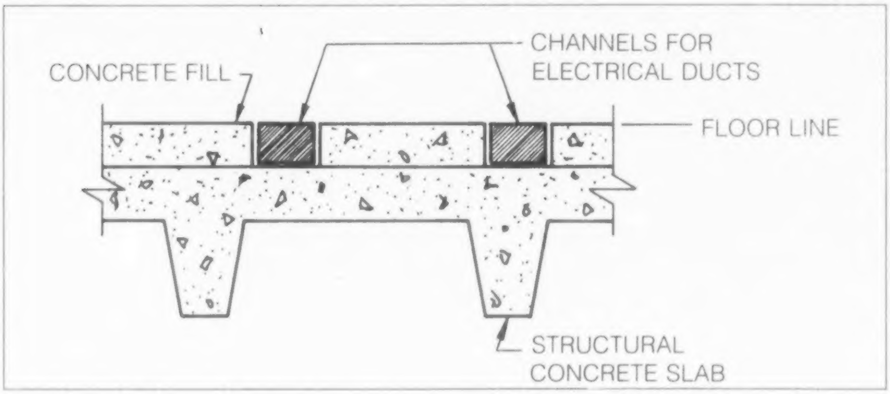
FIGURE 8: Cellular decking


CONCRETE-SLAB FLOOR
DECKING USED AS ELECTRICAL RACEWAY WITH A FLOOR-MOUNT OUTLET
STRUCTURAL DECKING ONLY
STRUCTURAL SUPPORT BEAM

c. **Channels**—Rectangular slots cut in concrete fill poured over structural-concrete slab floor

NOTE: Channels are used in structures with structural-concrete slab floors to form an underfloor electrical distribution system. Channels for electrical ducts are created by pouring an approximately 4-inch fill over the slab floor and then cutting rectangular slots in the concrete fill. See Figure 9.

FIGURE 9


CONCRETE FILL
CHANNELS FOR ELECTRICAL DUCTS
FLOOR LINE
STRUCTURAL CONCRETE SLAB

d. **Busways**—Large, heavy solid-copper or -aluminum bars surrounded by metal casing

NOTE: Busways are typically used in structures where a vast amount of electrical power is required at different locations (i.e., different floors). A busway is run to a required location and then plug-ins are installed on the busway to allow access to the electrical power the busway carries.

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e. **Cable trays**—Metal trays commonly hung from the ceiling with metal support brackets

NOTE: Cable trays are run overhead to carry large quantities of cabling in an efficient and safe manner.

6. **Major types of lighting sources and their descriptions**

NOTE: The type of lighting selected for a particular structure is largely determined by the functions to occur within the structure—whether the lighting needs are for general lighting, specific-task lighting, or lighting for areas of noncritical usage. Discussed below are the three major types of lighting available and some of the characteristics of each type.

a. **Fluorescent-lamp lighting**—Light source in which a phosphor coating transforms ultraviolet energy, produced by a discharge, into light; provides a general-use, diffuse light

NOTE: Fluorescent lighting is used extensively in commercial development because it provides a diffuse light and has a lamp life of approximately 10 times that of an incandescent lamp. Fluorescent lamps are commonly housed in standard-size units (i.e., 2′ × 4′) for placement in dropped acoustical ceiling grids.

b. **Incandescent-bulb lighting**—Light source in which a tungsten filament is heated to the point of illumination by an electrical current; provides a focused, direct light source

NOTE: Incandescent bulbs are popular in residential structures because of their inexpensive initial cost and because they come in a wide range of wattages. However, they are not popular in commercial and industrial applications because they have a relatively short lamp life and are not able to light a large area.

c. **High-intensity discharge** (HID) **lighting**—Gas-discharge light source utilizing mercury, sodium, or metal halide gas; provides an intense light in lamp-type form

NOTE: Extensively used for exterior lighting (lighting parking areas) or for interior lighting of structures with extremely high ceilings (warehouses), HID lighting is highly efficient and economical, and has a long lamp life.

7. **Common types of equipment requiring an electrical service load within commercial structures**

NOTE: A *load* is the electric current flowing through a circuit. Various types of equipment in a commercial structure will require an electrical service load. The loads required by this equipment must be considered in determining the structure's total energy requirements.

a. **Lighting**

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b. **Office equipment**

NOTE: In general, at least one convenience outlet is assumed for every 125 square feet of floor space accommodating office equipment.

c. **Data-processing equipment** (computers)

NOTE: Today, almost all commercial enterprises require computers for their effective operation. Commercial electrical-distribution systems must therefore provide dedicated wiring with an uninterrupted power source to meet these computer needs. The voltage requirements associated with a computer system are based on the number and size of the computers to be used.

d. **Heating, ventilating, and air-conditioning equipment**

NOTE: HVAC equipment includes such items as fans, pumps, heaters, motors, and compressors.

e. **Electric kitchen equipment**

NOTE: Although many commercial buildings include some kitchen equipment, in the case of restaurants, hospitals, and employee cafeterias, it is especially important that electrical loads be calculated for all electric kitchen appliances.

f. **Telephone equipment**

NOTE: Telephone service is provided by the telephone company into the structure to a main terminal room.

g. **Fire-alarm equipment**

NOTE: Fire-alarm equipment includes fire detectors, horns, bells, smoke detectors, and control panels. Fire-alarm equipment is wired to a separate power source so that the equipment will still function even in case of power failure to the main electrical system.

h. **Miscellaneous equipment**

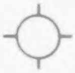
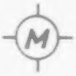
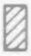
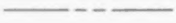
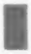
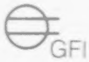
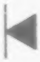
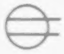
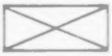
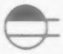
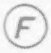
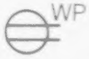
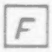
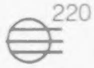
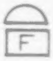
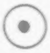
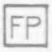
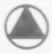
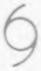
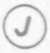
NOTE: Depending upon a structure's function, several other types of equipment may require electrical power. This equipment may include elevators, materials-handling equipment, laboratory equipment, medical equipment, etc. The electrical-load calculations for this type of equipment may be unique to each structure but still must be carefully considered.

INFORMATION SHEET

8. **Symbols used on electrical plans** (Table 1)

NOTE: Listed in the table below are the industry-standard electrical plan symbols used in commercial construction.

TABLE 1

Component name	Symbol	Component name	Symbol
Single-pole switch	S	Lighting outlet	
Three-way switch	S_3	Motor outlet	
Low-voltage switch	$\underline{S}$	Master power-service panel	
Low-voltage wire		Lighting-distribution panel	
GFI circuit		Telephone outlet	
Duplex receptacle outlet		Fluorescent-light troffer	
Split-wire receptacle outlet		Fire detector	
Weather-protected duplex outlet		Manual fire-alarm box	
220-volt outlet		Fire bell	
Floor outlet		Fire-alarm control panel	
Special-purpose outlet		Electric motor	
Junction box			

INFORMATION SHEET

9. **Types of drawings commonly completed for a structure's electrical system and their purposes**

   NOTE: Because of the size and complexity of the electrical systems of most commercial structures, it is often necessary to develop two separate electrical plans—one for the power-distribution system and one for the lighting system.

   a. **Electrical power-distribution plan**—Shows the location and distribution of all power sources in a structure, excluding lighting

   b. **Electrical lighting plan**—Shows the location of lighting-system components and information relating to those components

10. **Components of an electrical power-distribution plan** (see Figure 10)

    a. **Location and labeling information of the master service panel**

       NOTE: The master service panel is normally located in the switchgear room.

    b. **Location of all convenience outlets**

       EXAMPLES: Duplex receptacles, floor outlets, special-purpose outlets

    c. **Location of components of the fire-alarm system**

    d. **Location of components of the security system**

    e. **Location of components of the telephone system**

    f. **Location of power sources for all mechanical equipment**

       EXAMPLES: HVAC equipment, elevator motors, special-purpose wiring and/or outlets

    g. **Location of all circuit breakers**

    h. **Location of all branch power panels**

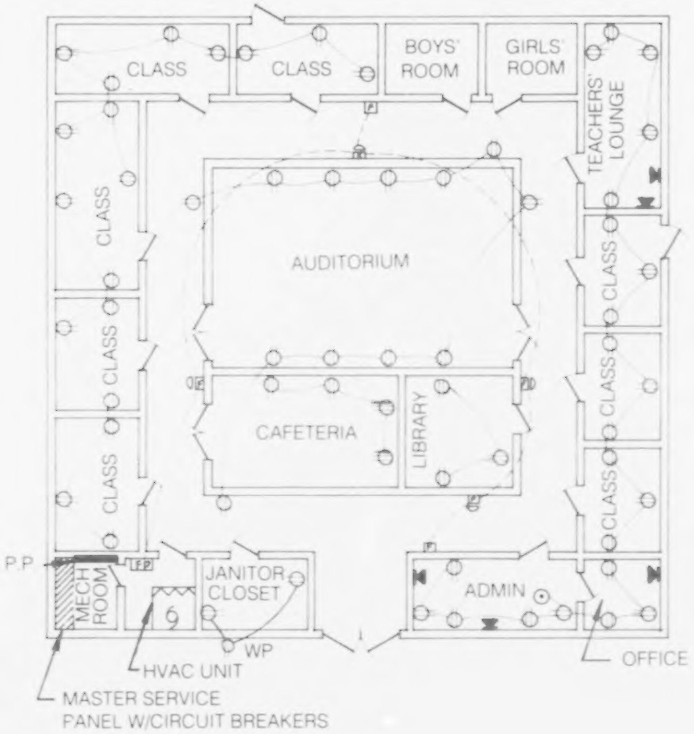
    i. **Necessary electrical schedules, legends, and notes** (where space permits)

    j. **Conduit size**

    k. **Conductor size**

INFORMATION SHEET

FIGURE 10: Electrical power-distribution plan


CLASS
CLASS
BOYS' ROOM
GIRLS' ROOM
TEACHERS' LOUNGE
CLASS
AUDITORIUM
CLASS
CLASS
CAFETERIA
LIBRARY
CLASS
CLASS
CLASS
P.P.
MECH ROOM
JANITOR CLOSET
ADMIN
WP
HVAC UNIT
OFFICE
MASTER SERVICE PANEL W/CIRCUIT BREAKERS

11. **Components of an electrical lighting plan** (see Figure 11)

    a. **Location of all light switches**

       EXAMPLES: Single-pole, double-pole, three-way

    b. **Location of all lighting fixtures and indications of which switch each fixture is connected to**

       NOTE: A dashed line is drawn connecting each light fixture to an appropriate switch.

    c. **Location of all lighting-panel boxes and indications that identify which structural area** (i.e., 4th floor) **is controlled by each panel box**

INFORMATION SHEET

d. **Reflected ceiling plan**

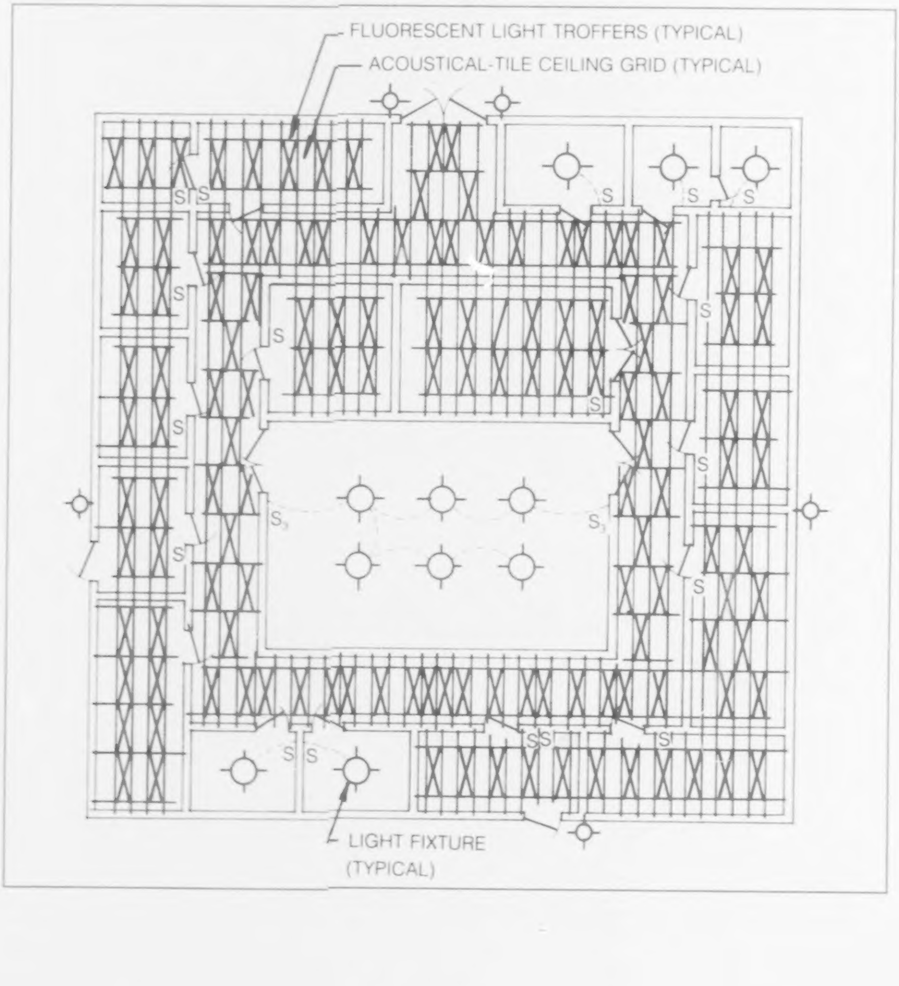
NOTE: A dropped acoustical-tile ceiling is used in a great many commercial structures. One of the advantages of this type of ceiling is the ability to use standard-size fluorescent-light troffers for general lighting purposes. A *reflected ceiling plan* is used to show the location of these lights. This type of plan is so named because the view is drawn as though a mirror were placed on the floor and the drafter viewed the ceiling's reflection in the mirror.

e. **Lighting-fixture schedule**

NOTE: If possible, the lighting-fixture schedule should be shown on the lighting-plan drawing.

f. **Necessary legends and notes**

FIGURE 11: Electrical lighting plan


FLUORESCENT LIGHT TROFFERS (TYPICAL)
ACOUSTICAL-TILE CEILING GRID (TYPICAL)
S
S_3
LIGHT FIXTURE (TYPICAL)

INFORMATION SHEET

12. Types of electrical schedules and their purposes

NOTE: In the development of a commercial electrical plan, the drafter will sometimes find it necessary to convey all the necessary information relating to electrical components in schedule form. Several common types of electrical schedules are listed below.

a. **Electrical-distribution schedule** (Table 2)—Provides a listing of the electrical circuits leading from the main (master) service panel and contains necessary technical information for service hook-up and installation

TABLE 2

Circuit number	Location serving	Elec load	Branch breaker size	Wire size	Conduit size
Panel #1	Master switch	400 KW	—	—	—
Panel #2	Lighting panel	110 KW	300 AMP	4/#0	4½"
Panel #3	Water heater	40 KW	215 AMP	3/#4	2¼"
Panel #4	HVAC equipment	132 KW	300 AMP	3/#4	2¼"
Panel #5	Cafeteria appliances	25 KW	150 AMP	3/#2	2"

b. **Electrical lighting-fixture schedule** (Table 3)—Supplies information about individual light fixtures, including manufacturer, model number, fixture type, quantity, and a description

NOTE: The lighting-fixture schedule is important as a means of supplying data for purchasing, cost-estimating, and inventory tracking.

TABLE 3

Ref	Manuf	Model number	Fixture type	Quantity	Description
A	GE	4907A	ID3	18	Incandescent downlight
B	GE	4907B	ID4	18	Incandescent downlight
C	Phillips	5310-2	VT	12	Mercury vapor w/reflector
D	Day-brite	DB2-2	AH2	8	1'×4' recessed flourescent
E	Day-brite	DB2-4	AH4	42	2'×4' recessed flourescent
F	Lite Co.	F442	AH44	5	4'×4' recessed flourescent

INFORMATION SHEET

c. **Electrical load and circuit schedule** (Table 4)—Provides electrical-load data and circuit information about each piece of equipment requiring electrical power

TABLE 4

Equipment name	Watts	Volts	Wires	Circuit breaker	Type of outlet	Notes
Heat pump motor	8000	120/240	2/#4	80 AMP	Tandem grounding	Direct-connected
Water heating plant motor	22000	120/240	2/#2	80 AMP	Parallel grounding	Direct-connected
Air cooling unit/mech room	9000	120/240	2/#8	45 AMP	Special purpose	Direct-connected
Refrigeration unit/cafeteria	6000	120/240	3/#6	30 AMP	Parallel grounding	Separate circuit
Fryer unit—cafeteria	12000	120/240	3/#6	50 AMP	Special purpose	Separate circuit

ELECTRICAL SYSTEMS
UNIT 10

STUDENT SUPPLEMENT 1—GUIDELINES FOR USING THE *NATIONAL ELECTRICAL CODE*

The *National Electrical Code* (NEC) is a handbook written and published by the National Fire Protection Association (NFPA). The NEC is the industry-recognized handbook for minimum electrical guidelines and is commonly referenced in local building-code requirements; therefore, it is especially important that you become familiar with the format and contents of this publication.

Format and content

The NEC contains nine chapters formatted much the same as the *Uniform Building Code* and the *Uniform Plumbing Code*, which you have studied in previous units. Each chapter covers a specific area of electrical construction. Chapter titles are listed below.

Chapter number	Chapter title
1	General
2	Wiring Design and Protection
3	Wiring Methods and Materials
4	Equipment for General Use
5	Special Occupancies
6	Special Equipment
7	Special Conditions
8	Communication Systems
9	Tables and Examples

ELECTRICAL SYSTEMS
UNIT 10

ASSIGNMENT SHEET 1—USE THE *NATIONAL ELECTRICAL CODE* TO ANSWER QUESTIONS CONCERNING STANDARDS FOR ELECTRICAL SYSTEMS

Name ______________________________ Score ______________

Introduction

A knowledge of the format and information contained in the *National Electrical Code* is essential to a drafter's understanding of how electrical-plan layouts are developed. Below are some questions designed to help you become more familiar with the format and content of the NEC.

Exercise

Directions

Study the information presented in Student Supplement 1, "Guidelines for Using the *National Electrical Code*." Then, using the NEC handbook, answer the following questions. Write your answers on the blanks provided after each question.

1. What is the topic of the requirements presented in Article 200 of Chapter 2?

   Topic ______________________________

2. In what chapter and article of the NEC would you find a listing of definitions?

   Chapter and article ______________________________

3. Article 240-2 lists where information concerning overcurrent protection can be found for various equipment. Which article contains information concerning overcurrent protection for industrial machinery?

   Article ______________________________

4. In what chapter and article would you find information concerning criteria for aircraft hangars?

   HINT: Use the NEC table of contents listing.

   Chapter and article ______________________________

5. Article 346-15 contains information about rigid-metal conduit. Paragraph c of that article states the labeling requirements for lengths of conduit. What is the per-foot requirement for clearly and durably labeling conduit?

   Per-foot requirement ______________________________

ELECTRICAL SYSTEMS
UNIT 10

ASSIGNMENT SHEET 2—COMPLETE A LIGHTING-FIXTURE SCHEDULE

Name ______________________ Score ____________

Introduction

The preparation of a complete and accurate lighting-fixture schedule is the responsibility of the drafter. Using information provided by an architect and/or an electrical engineer, the drafter can create a schedule that will speed up the purchase, inventory, and installation of all lighting fixtures for a structure.

Exercise

Directions

Study the scenario below, and then on an 8½" × 11" sheet of paper, prepare a complete and accurate lighting-fixture schedule for the office-building lighting plan detailed in the scenario.

Scenario

A printing business has just remodeled an old warehouse to serve as their new location. The building's layout will require the following light fixtures to serve the business needs:

- Six 2′ × 4′ fluorescent fixtures from the Metalux Company, model number MC-442A, fixture type AH4.
- Four 2′ × 2′ fluorescent fixtures from the Metalux Company, model number MC-22B, fixture type AH1.
- Two square, wall-mounted incandescent fixtures from Halo, Inc., model number H5510, fixture type ID6.
- Ten square, wall-mounted incandescent fixtures from Halo, Inc., model number H5700, fixture type ID8.
- Eleven square, wall-mounted incandescent fixtures from Spectrum Company, model number S-23A, fixture type IS4.
- Six emergency lights from H & H, Inc., model number HX-13, fixture type ET.
- Five two-head exterior floodlights from BASCO, Inc., model number 4TS-2215, fixture type FL-2.

ELECTRICAL SYSTEMS
UNIT 10

ASSIGNMENT SHEET 3—DEVELOP AN ELECTRICAL POWER-DISTRIBUTION PLAN

Name ______________________________ Score ______________

Introduction In this assignment sheet you will practice creating an electrical power-distribution plan of the fire-station project you have been developing in the past several units.

Exercise

Directions Locate and review the floor plan of the fire station you developed in Unit 4, Assignment Sheet 3, and on a clean sheet of vellum, lightly trace all structural features from the floor plan. Then study the specifications below and incorporate these specifications into the electrical power-distribution plan you develop for this project.

Specifications

- Locate the main electrical-distribution panel in the mechanical room.
- Use the NEC for determining minimum standards for convenience outlets (i.e., location, quantity, etc.), alarm systems, and any other special-purpose requirements.
- Include a legend, necessary notes, and any schedules that may be required.

ELECTRICAL SYSTEMS
UNIT 10

ASSIGNMENT SHEET 4—DEVELOP AN ELECTRICAL LIGHTING PLAN

Name ____________________________ Score ______________

Introduction

In this assignment sheet you will develop an electrical lighting plan for the fire-station project you have been developing in the past several units.

Exercise

Directions

Review the floor plan of the fire station you developed in Unit 4, Assignment Sheet 3, and on a clean sheet of vellum, lightly trace all structural features from the floor plan. Then study the specifications below and incorporate these specifications into the lighting plan you develop for this project.

Specifications

- Place 2′ × 4′ fluorescent-light troffers into dropped acoustical ceiling grid (as indicated on the section and detail drawings) in all rooms of the structure **except** the mechanical room and any bathrooms.

  Draw a reflected ceiling plan of all the rooms with the lights specified above.

- Place incandescent fixtures in the mechanical room and in the bathrooms.

  Use *Architectural Graphic Standards* to specify actual fixtures used.

- Show all switches and use a dashed line to indicate which lights are controlled by each switch.
- Draw a legend and develop a light-fixture schedule for the plan.
- Show any necessary notes and complete title-block information.

ELECTRICAL SYSTEMS
UNIT 10

WRITTEN TEST

Name ______________________________ Score ______________

1. Match terms associated with electrical systems to their correct definitions. Write the numbers on the blanks provided. Terms and definitions continue on the next page.

_____a. Opposition offered by a substance to the passage of a steady electric current

_____b. Electrical device used to open or close a circuit

_____c. Completed path for electrical current to flow from source to destination and then back to source

_____d. Wiring that runs from switchgear-room circuits to various electrical services throughout structure

_____e. Long, recessed light fixture with opening flush with ceiling

_____f. Container that protects conductor splices and provides support for electrical connections; designed to allow conductors to enter through knockouts in the sides and back

_____g. Incomplete electrical circuit not allowing the flow of electricity

_____h. Standard designation for wire of electrical conductors; the higher the designated number, the smaller the diameter of the wire

_____i. Handbook published by the National Fire Protection Association; sets forth minimum safety guidelines for electrical systems

_____j. Material that permits a flow of electricity

1. American wire gage
2. Circuit
3. Conductor
4. Feeder circuits
5. Junction box
6. *National Electrical Code*
7. Open circuit
8. Resistance
9. Switch
10. Troffer

WRITTEN TEST

______k. Destination point in wiring system at which the current can supply equipment requiring an electrical load

______l. Connection of comparatively low resistance accidentally made between points on a circuit between which the resistance is normally much greater

______m. Enclosure that houses the main power source for a structure's electrical system

______n. Enclosed channel for routing and placing electrical conductors and cables

______o. Device designed to increase or decrease voltage or current of an alternating-current circuit

______p. Schematic drawing showing the floor-to-floor layout of electrical connections, conduit, circuit breakers, and other electrical equipment

______q. Passageway for electrical wiring or cabling

______r. Movement or flow of electricity through a conductor

______s. Circuit that is a subdivision of main feeder circuit; usually serves a specific location or function

11. Short circuit
12. Raceway
13. Outlet
14. Electrical-distribution panel
15. Transformer
16. Conduit
17. Current
18. Branch circuit
19. Riser diagram

2. Match units of measure associated with electrical systems to their correct definitions. Write the numbers on the blanks provided.

______a. Measure of electrical pressure; equal to the electrical force applied to move the current of 1 ampere over a resistance of 1 ohm

______b. Measure of electrical resistance; equal to the resistance encountered when 1 ampere of current is driven by 1 volt

______c. Measure of electrical power equal to amps multiplied by volts; equal to 1 ampere of current flowing with an electromotive force of 1 volt

______d. Measure of the intensity of electric current; rate at which 1 volt of electricity flows through a conductor with 1 ohm of resistance

1. Ampere
2. Volt
3. Ohm
4. Watt

WRITTEN TEST

3. List the major subsystems of a commercial structure's electrical system. Write your answers on the blanks provided below.

   a. ______________________________

   b. ______________________________

   c. ______________________________

4. Match equipment and materials used in power-distribution systems to their correct definitions. Write the numbers on the blanks provided.

   ______a. Materials that do not permit the free flow of electricity

   ______b. Electro-mechanical devices containing a bimetal strip and a set of points; designed so that when excessive current flows through it, bimetal strip bends away from contact points and temporarily opens circuit until strip cools and again touches contact points

   ______c. Devices attached to the ends of two or more conductors or cables to allow connection of electric current without permanent splices

   ______d. Single-conductor wiring larger in size than no. 6 AWG, or two or more combined-conductor wiring of any size

   ______e. Tubes containing a soft-metal conductor; designed so that soft-metal conductor melts and permanently opens circuit when excessive current flows through it

   ______f. Single-conductor wiring no larger in size than no. 8 AWG

   1. Wires
   2. Cables
   3. Insulators
   4. Fuses
   5. Circuit breakers
   6. Connectors and terminals

WRITTEN TEST

5. Match materials used in installing electrical power-distribution systems to their correct definitions. Write the numbers on the blanks provided.

______a. Structurally supportive hollow galvanized-steel or polyvinyl-chloride tubing in which wiring and cabling are run

______b. Rectangular slots cut in concrete fill poured over structural-concrete slab floor

______c. Light-gage metal sheets with channels used to form electrical raceways for running wiring, cabling, or conduit

______d. Large, heavy solid-copper or -aluminum bars surrounded by metal casing

______e. Metal trays commonly hung from the ceiling with metal support brackets

1. Conduit
2. Cellular decking
3. Channels
4. Busways
5. Cable trays

6. Describe major types of lighting sources. Write your descriptions on the blanks provided beside each term below.

a. Fluorescent-lamp lighting ______________________________

____

____

____

b. Incandescent-bulb lighting ______________________________

____

____

____

c. High-intensity discharge lighting ______________________________

____

____

____

WRITTEN TEST

7. List 6 of the 8 common types of equipment requiring an electrical service load within commercial structures. Write your answers on the blanks provided below.

a. ______________________________

b. ______________________________

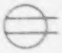
c. ______________________________

d. ______________________________

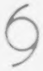
e. ______________________________

f. ______________________________

8. Label symbols used on electrical plans. Write your answers on the blanks under each of the illustrations below.



a. ____________________



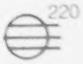
b. ____________________

Ⓕ

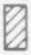
c. ____________________

S

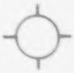
d. ____________________



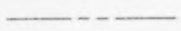
e. ____________________



f. ____________________



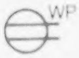
g. ____________________



h. ____________________

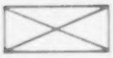
$\underline{S}$

i. ____________________

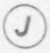


j. ____________________

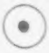
WRITTEN TEST



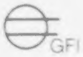
k. ______________________



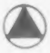
l. ______________________



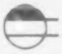
m. ______________________



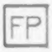
n. ______________________



o. ______________________



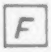
p. ______________________



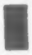
q. ______________________

S_3

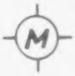
r. ______________________



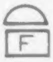
s. ______________________



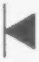
t. ______________________



u. ______________________



v. ______________________



w. ______________________

WRITTEN TEST

9. State purposes of the types of drawings commonly completed for a structure's electrical system. Write your answers on the blanks provided beside each term below.

   a. Electrical power-distribution plan ______________________________

   b. Electrical lighting plan ______________________________

10. List 7 of the 11 components of an electrical power-distribution plan. Write your answers on the blanks provided below.

    a. ______________________________
    b. ______________________________
    c. ______________________________
    d. ______________________________
    e. ______________________________
    f. ______________________________
    g. ______________________________

11. List 4 of the 6 components of an electrical lighting plan. Write your answers on the blanks provided below.

    a. ______________________________
    b. ______________________________
    c. ______________________________
    d. ______________________________

WRITTEN TEST

12. State purposes of types of electrical schedules. Write your answers on the blanks provided beside each of the terms below.

    a. Electrical-distribution schedule ______

    b. Electrical lighting-fixture schedule ______

    c. Electrical load and circuit schedule ______

PRESENTATION TECHNIQUES
UNIT 11

UNIT OBJECTIVE

After completing this unit, the student should be able to identify definitions of types of presentation drawings and state uses for types of rendering media and materials used to construct architectural models. The student should also be able to complete a two-point perspective, render drawings, and construct an architectural model. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with presentation techniques to their correct definitions.
2. Define the term *presentation drawing.*
3. Match types of presentation drawings to their correct definitions.
4. Match components of a perspective drawing to their correct descriptions.
5. State common uses for types of rendering media.
6. State uses for materials commonly used to construct architectural models.
7. Draw a two-point exterior perspective. (Assignment Sheet 1)
8. Render drawings. (Assignment Sheet 2)
9. Construct an architectural model. (Assignment Sheet 3)

PRESENTATION TECHNIQUES
UNIT 11

SUGGESTED ACTIVITIES

Preparation

- Review unit and plan presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review teaching suggestions given in the "Delivery and Application" section of this unit. Also note suggestions for media and supplemental materials.

- Obtain films, videotapes, and other media to supplement instruction of this unit. See ordering information in the "Suggested Resources" section.

- Make transparencies from the transparency masters included in this unit. Make copies of teacher supplement as required.

- Prepare classroom and lab. Put up posters, charts, and signs; display articles and other references related to the objectives of this unit.

Delivery and Application

Unit introduction

- Provide students with objective sheet. Discuss unit and specific objectives.

- Provide students with information sheet.

Objective 1 Match terms associated with presentation techniques to their correct definitions.

- Show students examples that illustrate the terms listed, and make examples available in the classroom.

Objective 2 Define the term *presentation drawing.*

- Invite an architectural drafter/designer to talk to the class about various presentation drawings and their importance as part of an overall project.

Objective 3 Match types of presentation drawings to their correct definitions.

- Discuss how elevation, site, and perspective drawings may be used to create presentation drawings. Use Transparencies 1 through 3 to illustrate your discussion.

- Discuss the concept behind a perspective drawing and the popularity and advantages of the two-point exterior perspective as a presentation drawing.

SUGGESTED ACTIVITIES

- Discuss the use of computer-generated drawings. Explain that they are becoming a popular tool for the architectural drafter, illustrator, or architect. The computer can quickly offer many different views of a structure, which allows for the selection of the best visual perspective. The selected view is then printed out to a hard copy that is used as a basis for completing the presentation drawing.
- Hand out copies of Teacher Supplement 1 to illustrate your discussion.

Objective 4 Match components of a perspective drawing to their correct descriptions.

- Discuss each of the six major components of any perspective drawing, which are presented in the objective. Use Transparencies 4 through 6 to illustrate your discussion.
- Draw a simple perspective on the chalkboard. Adjust the station point and horizon line, and then redraw the perspective. Discuss the changes that take place in the perspective view.

Objective 5 State common uses for types of rendering media.

- Read the note introducing the objective in the information sheet. Explain that renderings are additions to a drawing that create a realistic graphic representation. Then discuss the types of media used to create these renderings.
- Show examples of renderings that use media described in the objective. Discuss the advantages and disadvantages of each type of media.

Objective 6 State uses for materials commonly used to construct architectural models.

- Read to students the note introducing the objective. Explain the importance of an architectural model as part of an overall project.
- Discuss the materials used in architectural model making and their specific applications. Ask students to list any other materials they might use for model making and state an application for each material listed.

Assignment Sheets 1 through 3

Assignment Sheet 1 Draw a two-point exterior perspective.

- Hand out Assignment Sheet 1 and Student Supplement 1, "Steps in Drawing a Two-Point Perspective."

SUGGESTED ACTIVITIES

- Have students locate the floor plan of the fire station they completed in Unit 4, Assignment Sheet 3.
- Discuss with students the drawing sequence presented in the student supplement, and then read the introduction and directions to the exercise in the assignment sheet.
- Carefully review with students the drawing specifications also presented in the assignment sheet.
- Answer any student questions, and then have students complete Assignment Sheet 1.

Assignment Sheet 2 Render drawings.

- Hand out Assignment Sheet 2 and Student Supplement 2, "Guidelines for Rendering Drawings."
- Discuss the concepts of shades, shadows, and texture presented in Student Supplement 2, and explain how these techniques are used in an architectural rendering.
- Have each student select three different objects from the classroom to draw. Each object should be different in shape and material. Have the students shade and shadow each object after they have sketched it, and then have students use a different shading technique for each object.
- Illustrate on the chalkboard an example of each of the rendering techniques discussed in Student Supplement 2. Explain when each of these techniques would be useful and why.
- Have students locate the elevation plan of the fire station they used in completing Assignment Sheet 1 of this unit.
- Read the introduction and directions to the exercise in the assignment sheet and carefully review with students the drawing specifications also presented in the assignment sheet.
- Answer any student questions and then have students complete Assignment Sheet 2.

Assignment Sheet 3 Construct an architectural model.

- Hand out Assignment Sheet 3 and discuss the introduction to the assignment and the directions to the exercise.
- Answer any student questions and then have students complete Assignment Sheet 3.

SUGGESTED ACTIVITIES

Evaluation

- Give written test.
- Compile written-test and assignment-sheet scores on Unit Evaluation Form.
- Reteach and retest as required.

Suggested Resources

Resources used in developing unit

Print media

- Kuckein, H. E. *Architectural Illustration and Presentation*. Reston, Virginia: Reston Publishing, 1984.
- Muller, Edward. *Architectural Drawing and Light Construction*. Englewood Cliffs, New Jersey: Prentice-Hall, 1985.
- Spence, William P. *Architecture: Design—Engineering—Drawing*. Mission Hills, California: Glencoe Publishing, 1985.

Additional resources

Print media

- Helper, Donald E. *Architecture—Drafting and Design*, 5th ed. New York: McGraw-Hill, 1987.
- Lewis, Jack R. *Architectural Draftsman's Reference Handbook*. Englewood Cliffs, New Jersey: Prentice-Hall, 1982.

Media

- *Architectural Rendering*. Available on VHS or filmstrip. Opportunities for Learning, Inc., 20417 Nordhoff Street, Dept. R, Chatsworth, California 91311.

  This production is about the use of perspective drawings and their advantages, and also shows several examples of architectural renderings.

PRESENTATION TECHNIQUES
UNIT 11

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1	Evaluated to the satisfaction of the instructor.
Assignment Sheet 2	Evaluated to the satisfaction of the instructor.
Assignment Sheet 3	Evaluated to the satisfaction of the instructor.

PRESENTATION TECHNIQUES
UNIT 11

ANSWERS TO WRITTEN TEST

1. a. 8
   b. 3
   c. 4
   d. 5
   e. 7
   f. 11
   g. 1
   h. 12
   i. 9
   j. 2
   k. 6
   l. 10
   m. 13

2. Any of a number of drawing types that attempt to show a visual representation of a finished structure in its natural setting

3. a. 2
   b. 1
   c. 3

4. a. 2
   b. 1
   c. 3
   d. 4
   e. 6
   f. 5

5. a. Used for sketching and for achieving varying line widths and shading
   b. Used for creating fine, detailed linework of good reproduction quality
   c. Used to produce rich colors and a distinctive look
   d. Used to provide an unlimited array of color and contrast
   e. Used to provide shading and reference figures
   f. Used to produce shades and shadows in subtle variations

6. a. Used to construct model base
   b. Used to form contours on model base
   c. Used to construct floors, walls, and roof of structure
   d. Used to construct exterior trim
   e. Used to construct windows
   f. Used to simulate roofing and asphalt shingles
   g. Used to simulate stucco
   h. Used to construct lamp posts
   i. Used to construct trees and shrubs

PRESENTATION TECHNIQUES
UNIT 11

UNIT EVALUATION FORM

Student name ______________________ Unit rating ________

Assignment sheet ratings

Assignment Sheet 1—Draw a Two-Point Exterior Perspective Rating ________

Comments: ______________________

Assignment Sheet 2—Render Drawings Rating ________

Comments: ______________________

Assignment Sheet 3—Construct an Architectural Model Rating ________

Comments: ______________________

Written test scores

Pretest ________ Other ________

Posttest ________

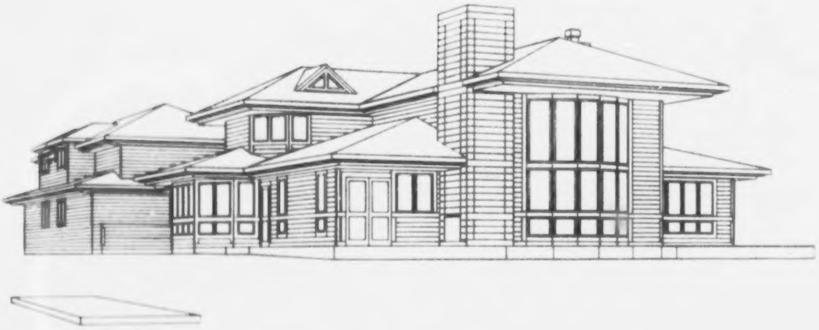
Instructor signature ______________________ Date ________

Student signature ______________________ Date ________

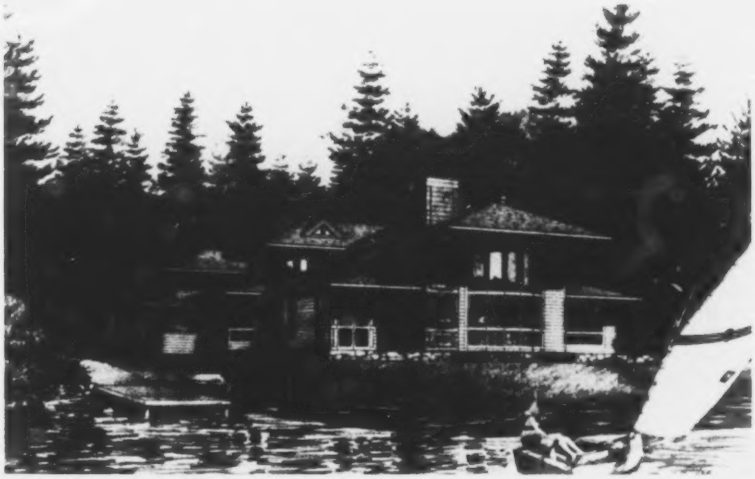
Duplication of this form is permitted.

PRESENTATION TECHNIQUES
UNIT 11

TEACHER SUPPLEMENT 1—COMPUTER-GENERATED PRESENTATION DRAWING



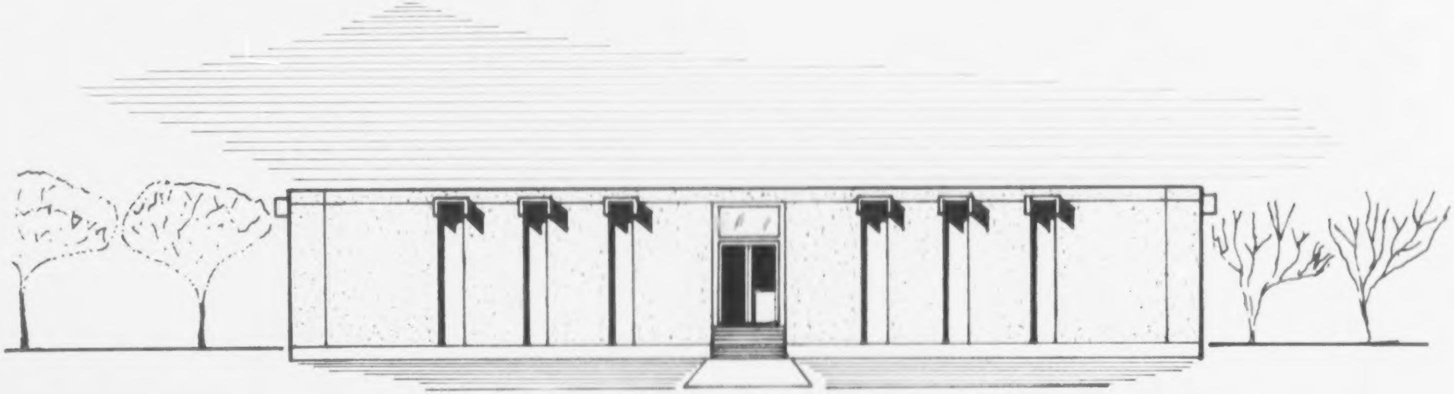
Computer-generated perspective



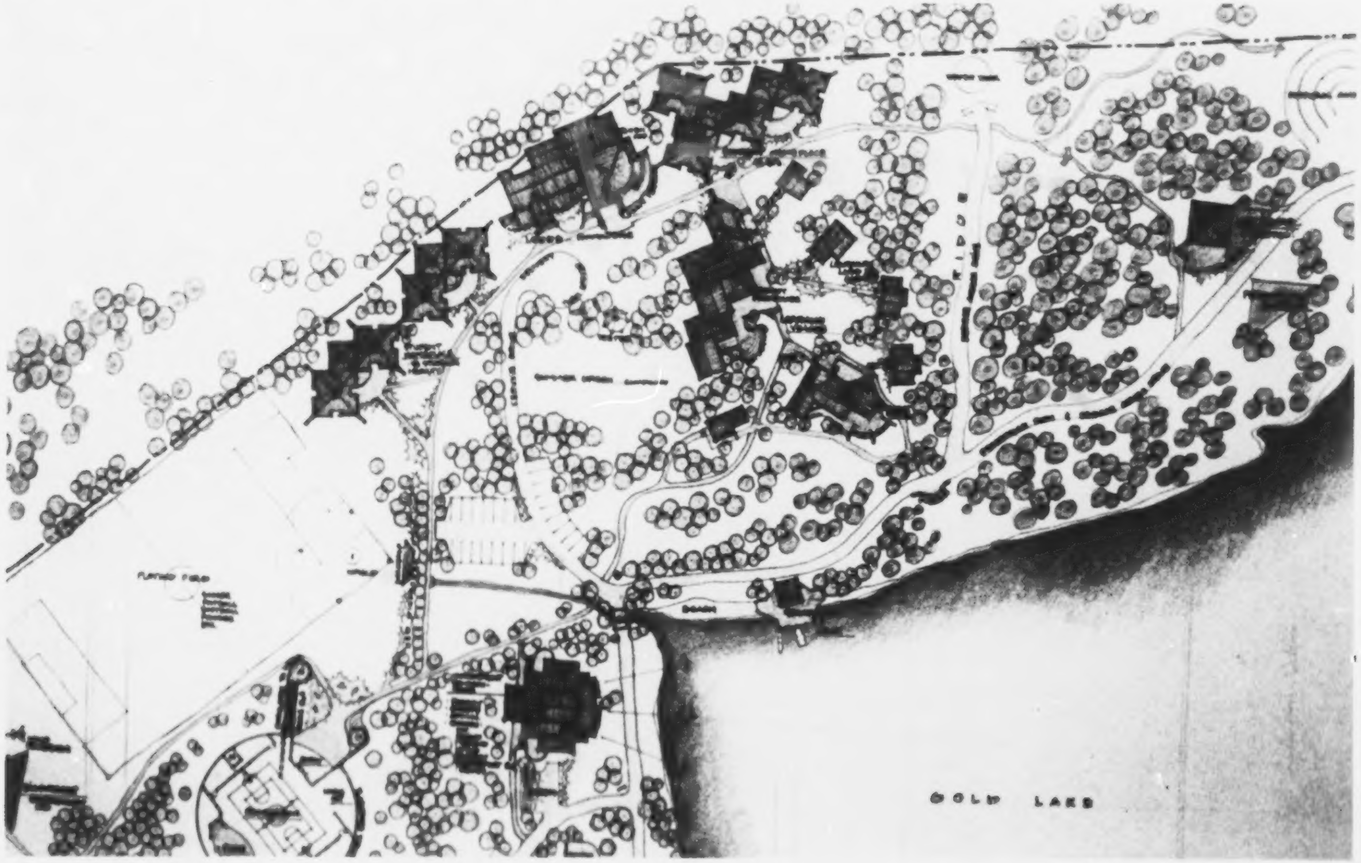
Finished presentation drawing

Drawings courtesy of Daniel C. Pullen, architect, Boulder, Colorado.

Elevation Presentation Drawing



Site Presentation Drawing



Courtesy of David Barrett, AIA, Forest Studio, Boulder, Colorado.

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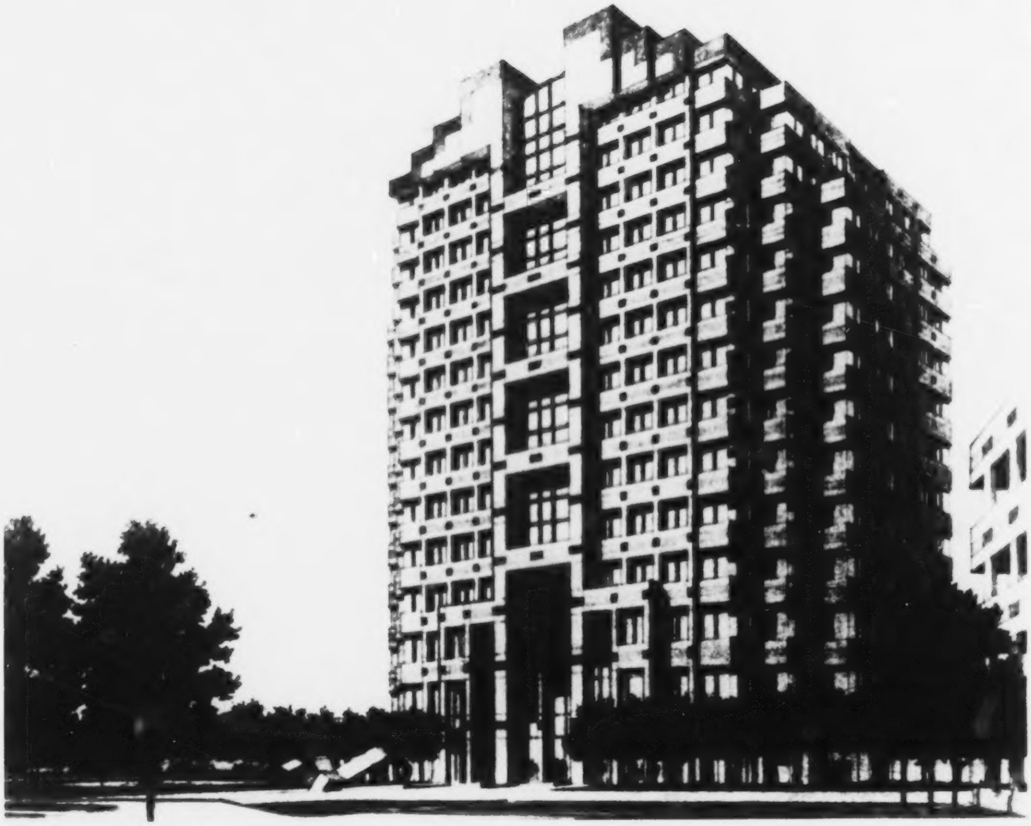
Two-Point-Perspective Presentation Drawing



Drawing courtesy of Daniel C. Pullen, architect, Boulder, Colorado.

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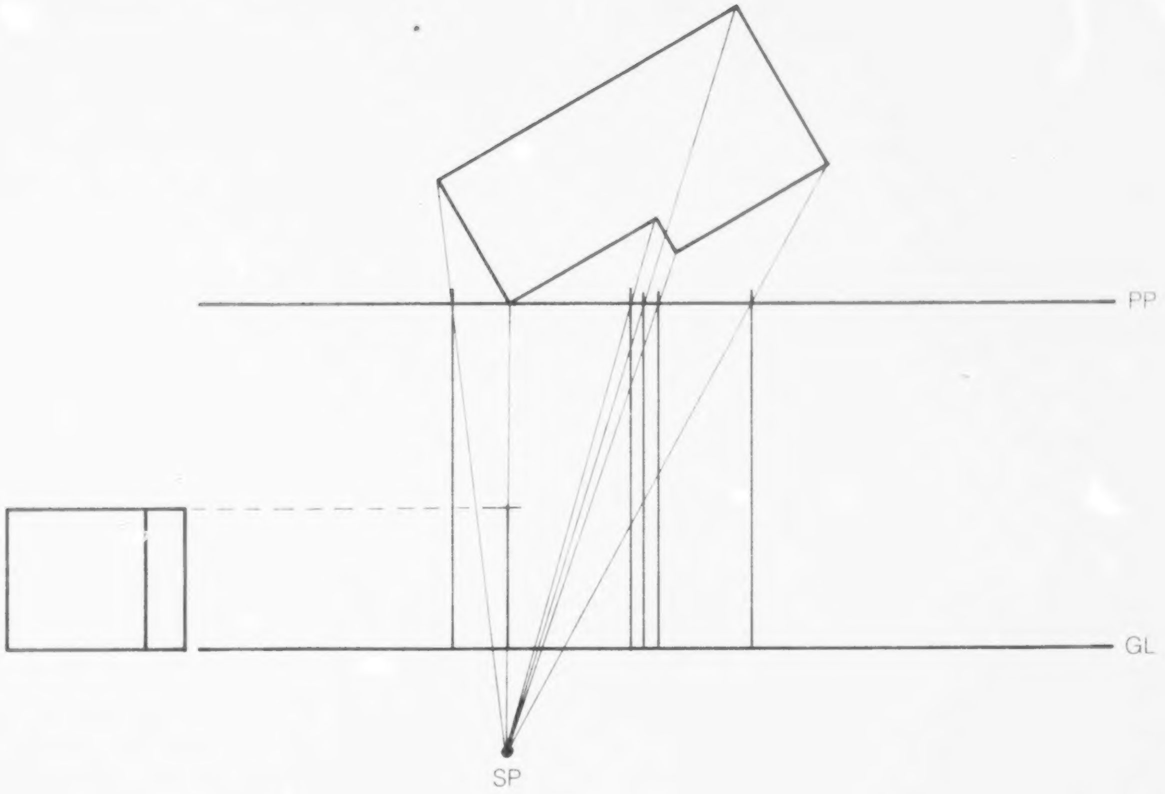
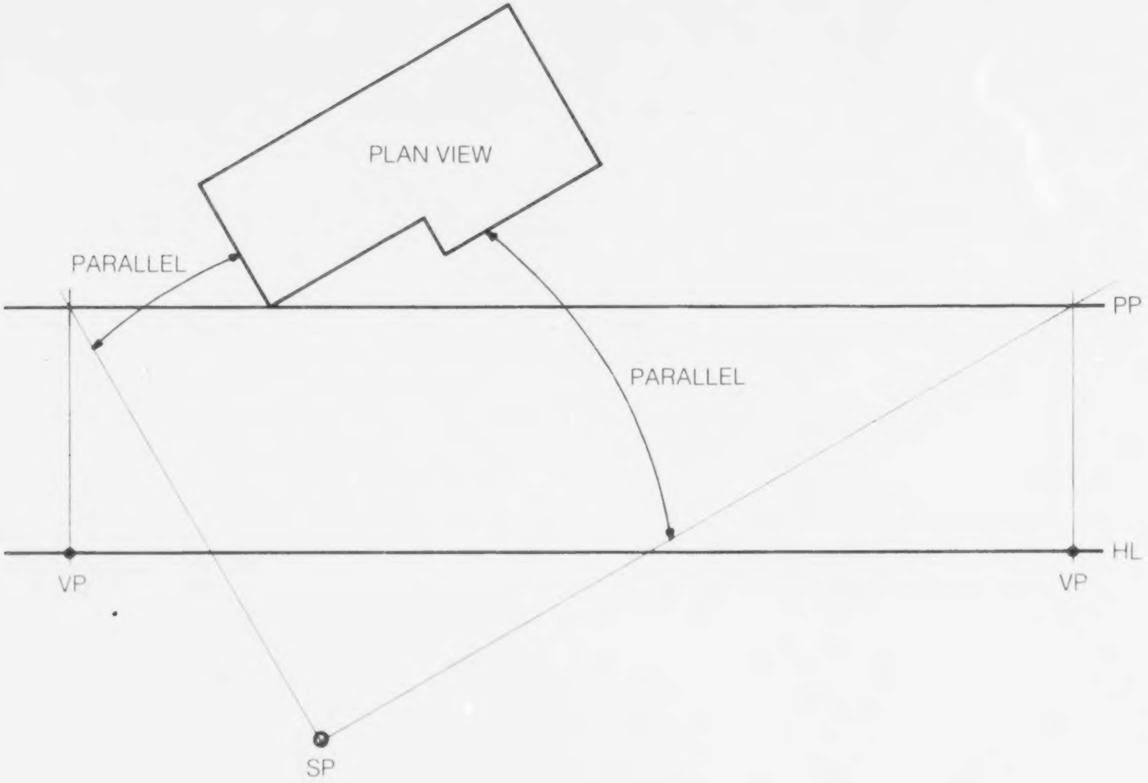
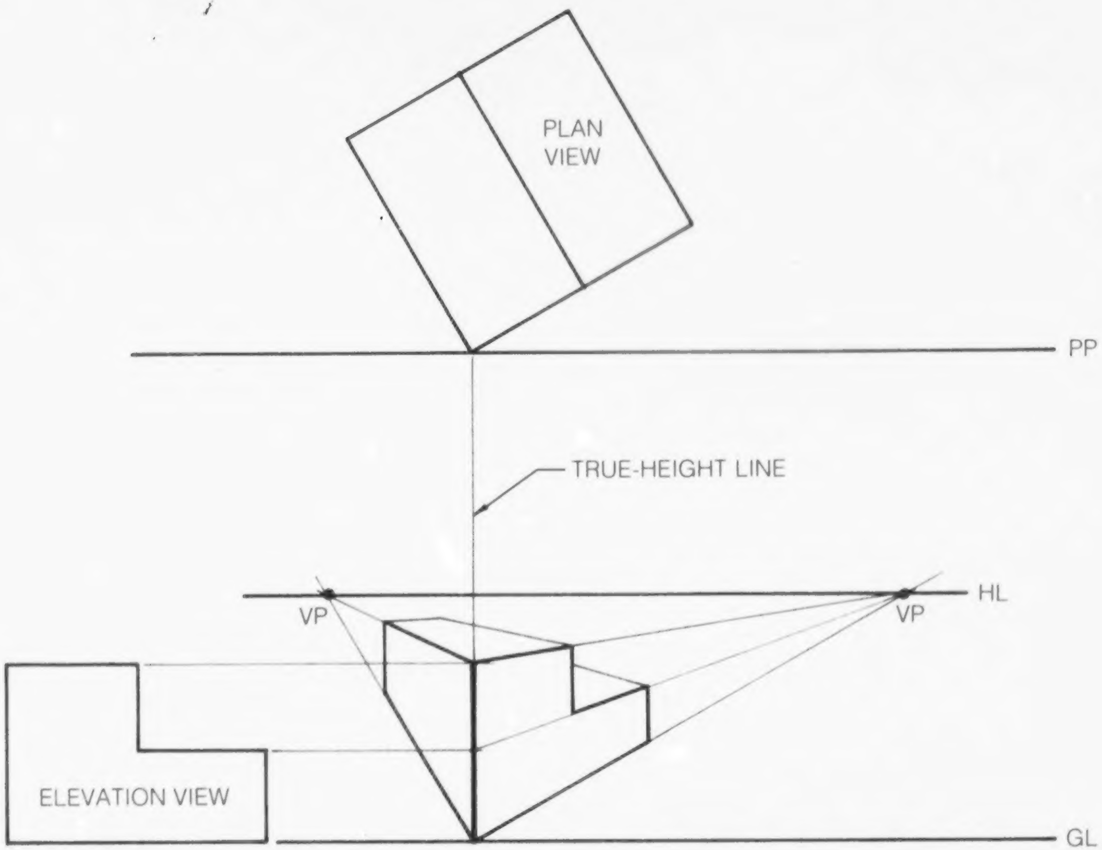
Components of a Perspective Drawing



Components of a Perspective Drawing
(Continued)


PLAN VIEW
PARALLEL
PARALLEL
PP
HL
VP
VP
SP

Components of a Perspective Drawing
(Continued)


PLAN VIEW
PP
TRUE-HEIGHT LINE
VP
HL
VP
ELEVATION VIEW
GL

PRESENTATION TECHNIQUES
UNIT 11

INFORMATION SHEET

1. **Terms and definitions associated with presentation techniques**

   a. **Air brush**—Small, air-pressure-controlled paint gun

   b. **Applique**—Pressure-sensitive, adhesive-backed transparent film used as transfer media

   c. **Balsa wood**—Extremely light wood used in making architectural models

   d. **Chipboard**—Compressed wood-fiber material produced as sheets of varying thicknesses

   e. **Foam core**—Compressed styrofoam material produced as sheets of varying thicknesses

   f. **Perspective**—Three-dimensional pictorial drawing made by projecting points through a fixed plane from a fixed point of observation

   NOTE: A perspective drawing closely represents a structure as it would appear to the human eye.

   g. **Picture plane**—Transparent vertical plane through which a plan view is projected in a perspective drawing

   h. **Reference figure**—Figure used in drawings and models to relate the scale of a structure

   EXAMPLES: People, cars, landscaping, other man-made objects

   i. **Rendering**—Adding shade, color, shadow, texture, reference figures, landscaping, and other features to a drawing in order to give a more realistic perception of a structure

   j. **Shade**—Condition created when a surface is not perpendicular to a light source

   k. **Shadow**—Condition created when light is excluded by a shaded surface

   l. **Texture**—Visual or tactile quality of a surface

   m. **Watercolor**—Transparent, water-based paint

2. **Definition of the term *presentation drawing***—Any of a number of drawing types that attempt to show a visual representation of a finished structure in its natural setting

   NOTE: A presentation drawing is an important design tool developed to give clients, bankers, city planning commissions, corporate officers, and other laymen a true visual representation of a structure, its overall proportion, and its relationship to its surroundings.

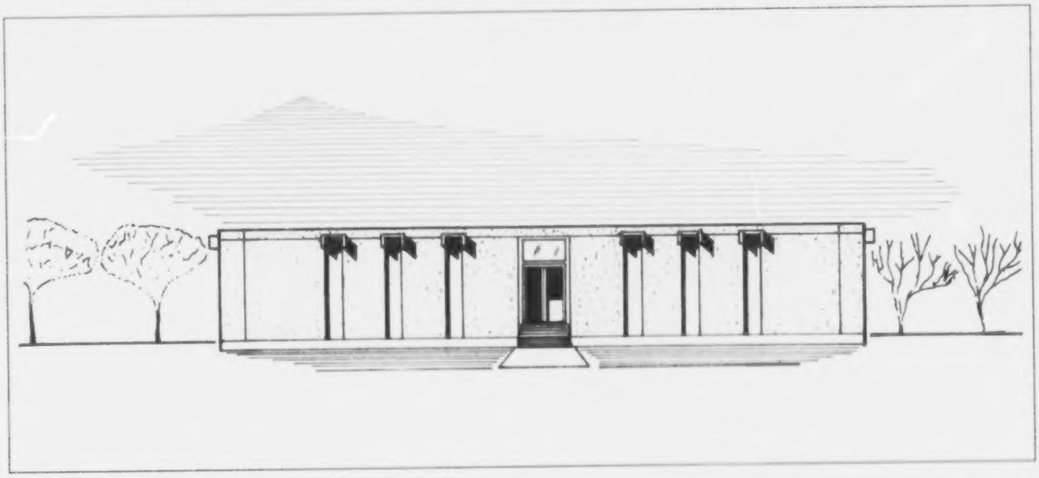
INFORMATION SHEET

3. Types of presentation drawings and their definitions

a. **Elevation** (Figure 1)—Vertical, two-dimensional view showing shape and design of each of the exterior or interior faces of a structure

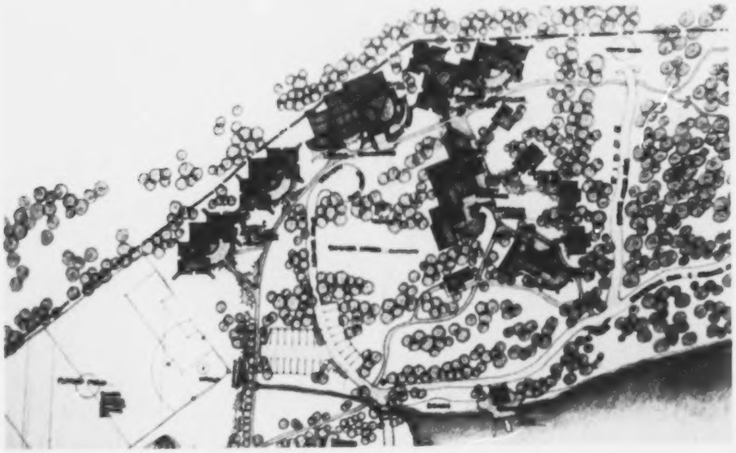
NOTE: Elevation drawings are commonly used as presentation drawings because of the great time savings when compared to other types of drawings. By adding some shading, shadows, texture, color, landscaping, and/or reference figures, a drafter can turn a simple elevation drawing into an attractive presentation drawing.

FIGURE 1: Elevation presentation drawing



b. **Site** (Figure 2)—Drawing developed by rendering an existing site plan to produce a plan view of a structure and its surroundings

FIGURE 2: Site presentation drawing



Courtesy of David Barrett, AIA, Forest Studio, Boulder, Colorado.

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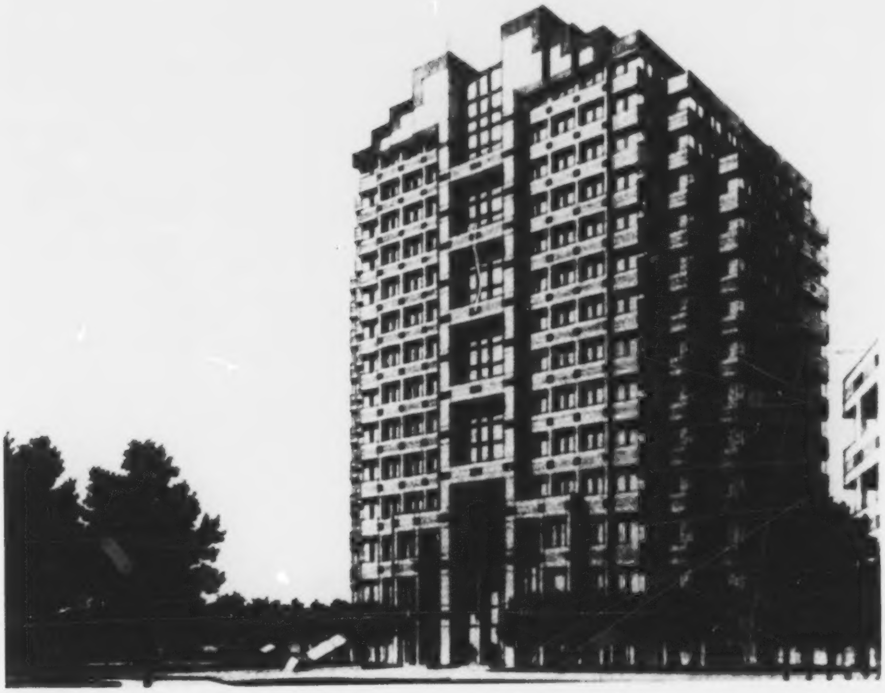
INFORMATION SHEET

c. **Two-point perspective** (Figure 3)—Perspective drawing that contains two vanishing points and positions the structure at an angle to the picture plane

NOTE: Even though they are the most complex of the types of presentation drawings, two-point perspectives are by far the most popular method of developing an exterior view of a structure because they show two adjacent sides of a structure in true visual proportion and are more visually accurate and pleasing to the eye.

FIGURE 3: Two-point-perspective presentation drawing



Drawing courtesy of Daniel C. Pullen, architect, Boulder, Colorado.

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INFORMATION SHEET

4. Components of a perspective drawing and their descriptions

NOTE: A drafter must understand the components of a perspective drawing because the use and placement of the components allow for variations in the perspective views achieved.

a. **Ground line** (GL) (see Figure 4)—Line representing the surface an object rests on; acts as the reference line from which the horizon line is determined

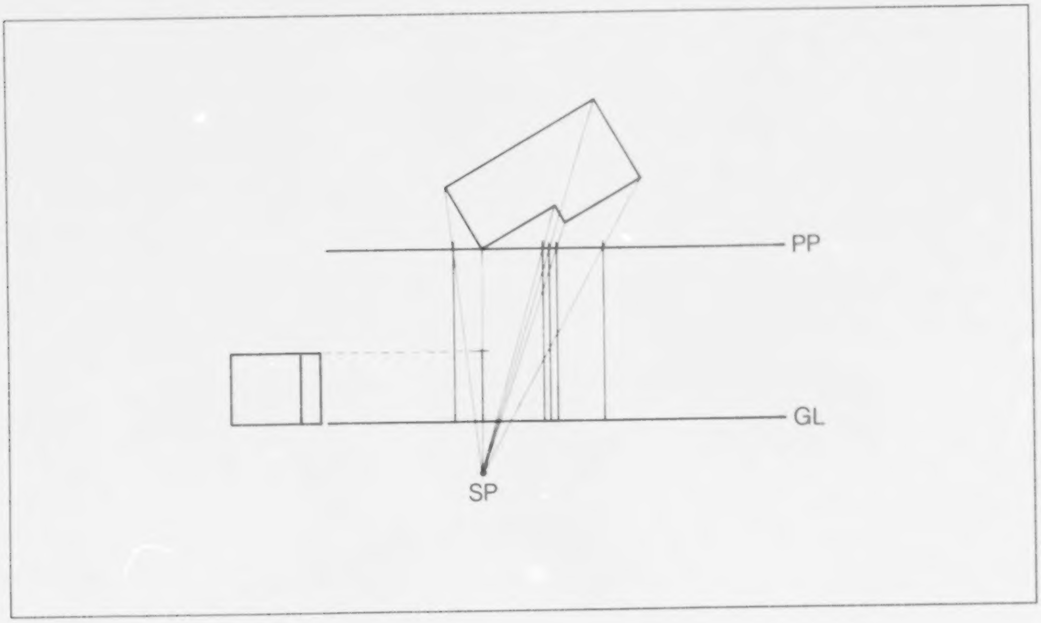
NOTE: The ground line represents the bottom edge of the picture plane.

b. **Picture-plane line** (PP) (see Figure 4)—Horizontal line representing the top edge of the picture plane; acts as the reference line from which all horizontal measurements of the perspective are determined

c. **Station point** (SP) (Figure 4)—Assumed reference point of the observer's eye

NOTE: The placement of the station point on a perspective drawing determines what view of the structure will be seen. In order to achieve a balance between two sides of a structure being shown, the station point is generally located along the center line of the intersection of the two adjacent sides being seen in the perspective. Then every line dropped down from the picture-plane line is projected from the station point, through the picture-plane line, to the desired point on the structure.

FIGURE 4

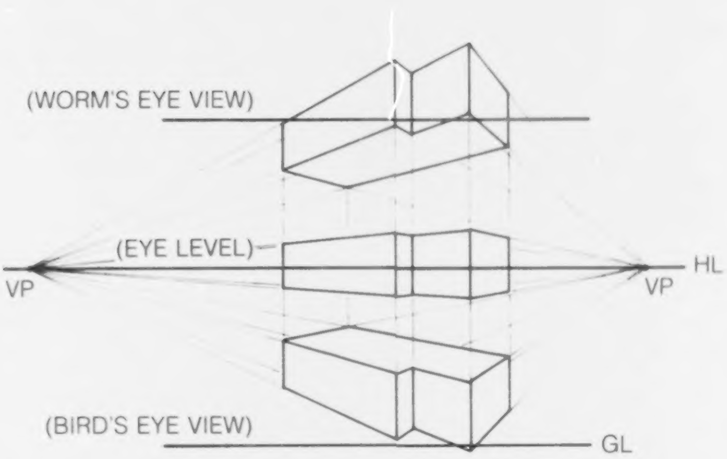


INFORMATION SHEET

d. **Horizon line** (HL)—Line indicating observer's eye level above or below the ground line

NOTE: The horizon line is placed at the height from which the observer would view the structure. This height is measured from the ground line and is usually placed above the ground line; however, occasionally a drafter will produce a *worm's eye view* or a *bird's eye view*. A worm's eye view is produced by positioning the horizon line below the ground line. If the horizon line is placed above a viewer's normal eye level (i.e., 5′-0″ to 6′-0″), the resulting perspective will produce a bird's eye view, in which it appears the viewer is looking at the object from above. See Figure 5.

FIGURE 5

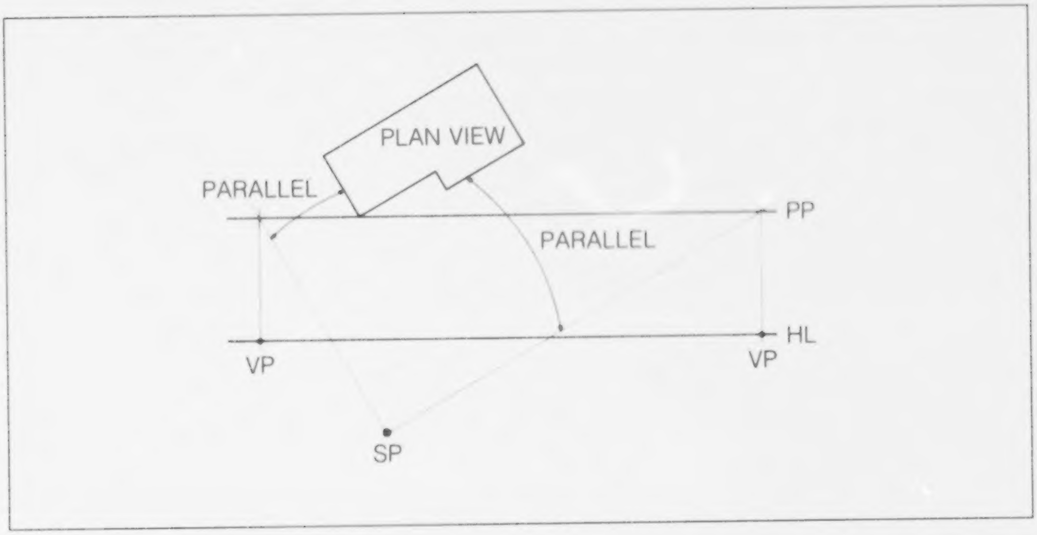


e. **Vanishing point** (VP) (see Figure 6)—Point on the horizon line at which receding lines appear to meet; acts as the point from which all non-height lines recede

NOTE: Vanishing points are created by projecting from the station point lines drawn parallel to the plan view of the structure, extended to the picture-plane line, and then dropped vertically to the horizon line.

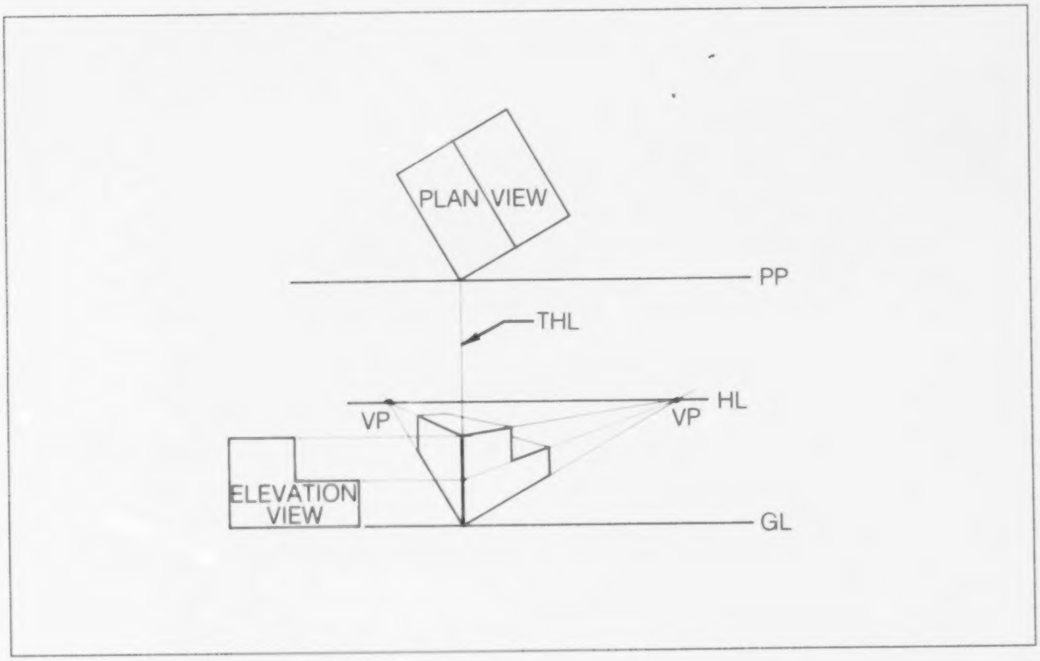
INFORMATION SHEET

FIGURE 6


PLAN VIEW
PARALLEL
PP
PARALLEL
HL
VP
VP
SP

f. **True-height line** (THL) (Figure 7)—Vertical line of the plan view that touches the picture-plane line; appears as the actual height of the scaled drawing, with all other lines receding to the appropriate vanishing point

FIGURE 7


PLAN VIEW
PP
THL
HL
VP
VP
ELEVATION VIEW
GL

INFORMATION SHEET

5. **Types of rendering media used on presentation drawings and their common uses**

NOTE: In most cases, a presentation drawing will not suffice in providing a client with the overall effect the architect wants conveyed—a realistic graphic representation of the finished structure. To create that overall effect, a drafter develops an architectural rendering, which supplies color, texture, shading, optical balance, and contrast. Architectural renderings are produced using various types of media. Listed below are types of media used and their common uses.

a. **Pencils**—Used for sketching and for achieving varying line widths and shading

NOTE: Pencils are effective tools for rendering drawings, and pencil lines have the advantage of being easily erased if corrections are necessary.

b. **Pen and ink**—Used for creating fine, detailed linework of good reproduction quality

NOTE: The main advantage of pen-and-ink rendering is its reproduction quality; one disadvantage is that pen-and-ink rendering is a time-consuming process, especially on larger drawings.

c. **Felt-tip markers**—Used to produce rich colors and a distinctive look

NOTE: While felt-tip markers are used by drafters for their color quality, markers are very difficult to use when the drafter must draw fine lines or complete detail work.

d. **Watercolors**—Used to provide an unlimited array of color and contrast

NOTE: Watercolors are an excellent media for rendering large drawings.

e. **Appliques**—Used to provide shading (dots, lines, colors) and reference figures (landscape objects, human figures, automobiles, and construction materials)

NOTE: The main advantage of appliques is that they can be quickly applied.

f. **Air brush**—Used to produce shades and shadows in subtle variations

NOTE: A drafter can produce excellent results with an air brush, but may find this rendering technique difficult to master.

6. **Materials commonly used to construct architectural models and their uses**

NOTE: A scaled architectural model—a three-dimensional miniature of a structure—is often created for large, complex, or expensive structures. The model is often used in a public display to help gain community and financial support for the project. A drafter may construct an architectural model of a structure, or the model may be built by professionals who specialize in this art. (See Figure 9.)

INFORMATION SHEET

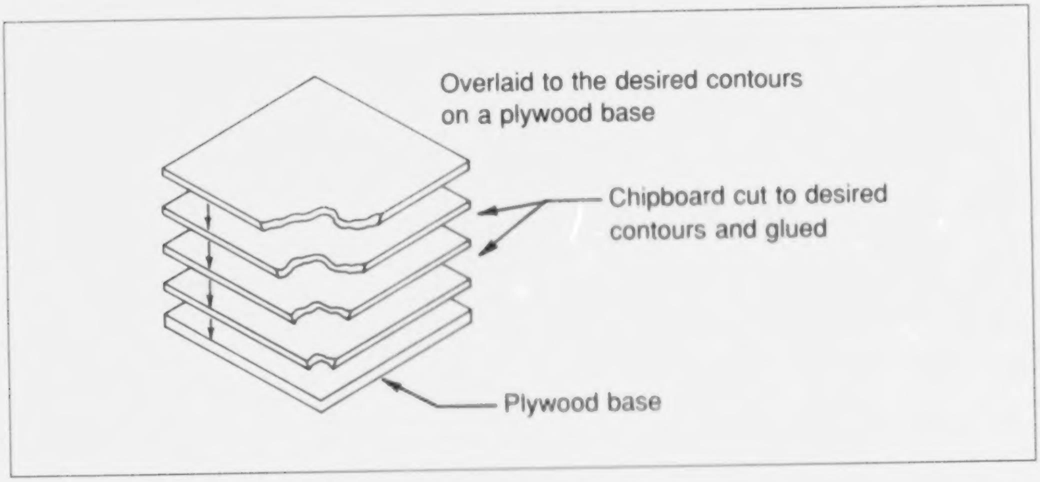
An unlimited number of materials can be used by a model builder. Listed below are only some of the materials commonly used. Model and hobby stores are excellent sources for finding ready-made objects and other materials that can be used in model making.

a. **½- or ¾-inch plywood**—Used to construct model base

b. **⅛- or 3/32-inch chipboard**—Used to form contours on model base

NOTE: A model must have a sturdy base to support the rest of the structure—½- or ¾-inch plywood is used to construct the base for a structure on a site; ⅛- or 3/32-inch chipboard is used to construct any required contours. The chipboard is cut and then overlaid on the plywood base to the desired contour configuration. See Figure 8.

FIGURE 8


Overlaid to the desired contours on a plywood base
Chipboard cut to desired contours and glued
Plywood base

c. **Cardboard, balsa-wood, foam-core sheets**—Used to construct floors, walls, and roof of structure

NOTE: Cardboard, balsa-wood, and foam-core sheets are used to form the shell of the structure, and then these materials are either painted or covered with printed paper sheets that simulate building materials such as brick, block, or stone.

d. **Clear plastic**—Used to construct windows

e. **Balsa-wood strips, toothpicks, dowels, heavy illustration board**—Used to construct exterior trim

f. **Sandpaper**—Used to simulate roofing and asphalt shingles

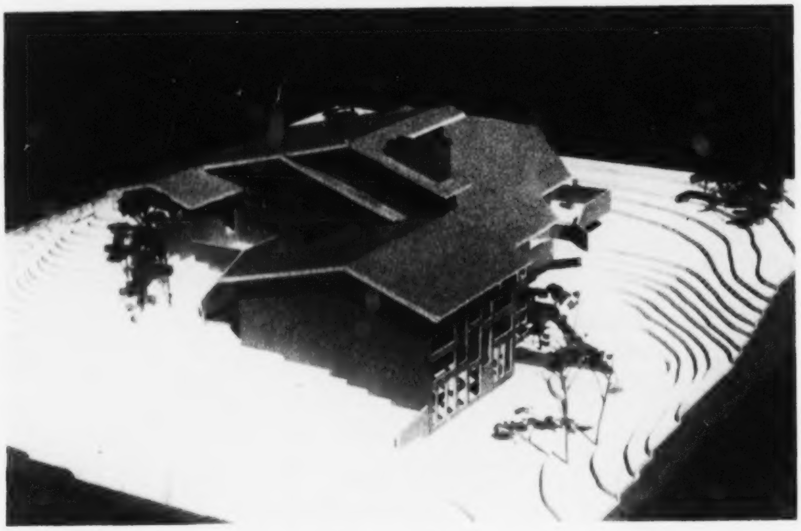
g. **Mixture of sand and paint**—Used to simulate stucco

INFORMATION SHEET

h. **Wire**—Used to construct lamp posts

i. **Dried twigs or weeds**—Used to construct trees and shrubs

FIGURE 9: Architectural model



Courtesy of Pam McFadden, AIA, Boulder, Colorado.

PRESENTATION TECHNIQUES
UNIT 11

STUDENT SUPPLEMENT 1—STEPS IN DRAWING A TWO-POINT PERSPECTIVE

Listed below is the recommended drawing sequence for producing a two-point perspective. This drawing sequence should be used in completing Assignment Sheet 1, "Draw a Two-Point Exterior Perspective."

Drawing sequence

1. Draw a horizontal line across the upper portion of the drawing and label this line as the picture-plane line.

2. Draw a horizontal line across the bottom portion of the drawing and label this line as the ground line.

3. Draw in the elevation view on the ground line.

4. Draw in the plan view with the front face of the structure at an angle (usually 30 degrees) to the picture-plane line, with the front corner of the plan view intersecting the picture-plane line.

5. Locate the station point directly below the corner of the plan view at a desired location, usually at a location two times the distance of the longest side of the plan view.

6. At the desired observation height, locate and draw in the horizon line across the drawing.

7. Parallel to the side of the plan view, draw lines from the station point that extend out to the picture-plane line. Then drop a vertical line from each point where the picture-plane line was crossed, down to the horizon line.

   NOTE: Where these lines intersect the horizon line are where the two vanishing points exist for the perspective.

8. Project down all necessary points from the plan view, through the station point, to the picture-plane line.

9. Drop the lines from the picture-plane line vertically down to the perspective view.

10. Determine object heights by projecting the required height line from the elevation view to the true-height line in the perspective view. Then project the points on the true-height line back toward the vanishing points. Where these lines intersect the corresponding vertical lines dropped from the picture plane are where these points exist in the perspective view.

11. Determine all necessary points in the perspective view, and darken in the linework to produce the finished perspective.

12. Erase all projection lines as necessary to make the perspective view stand out.

PRESENTATION TECHNIQUES
UNIT 11

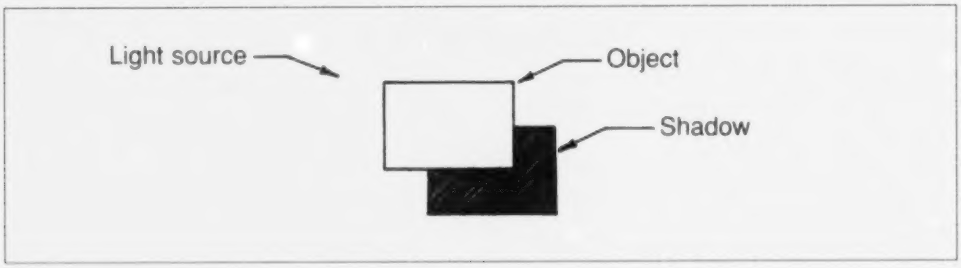
STUDENT SUPPLEMENT 2—GUIDELINES FOR RENDERING DRAWINGS

A presentation drawing uses shades, shadows, and other types of rendering techniques as an integral part of the drawing. The correct representation of a light source on the rendered object is as important as the object itself, and rendering techniques help provide a more complete and dramatic effect. Listed below are some of the guidelines used to render drawings. These guidelines should be used in completing Assignment Sheet 2.

Guidelines for creating shades and shadows

1. An angle of light source is always determined for a drawing, usually coming from the upper-left corner, unless otherwise indicated. See Figure 1.

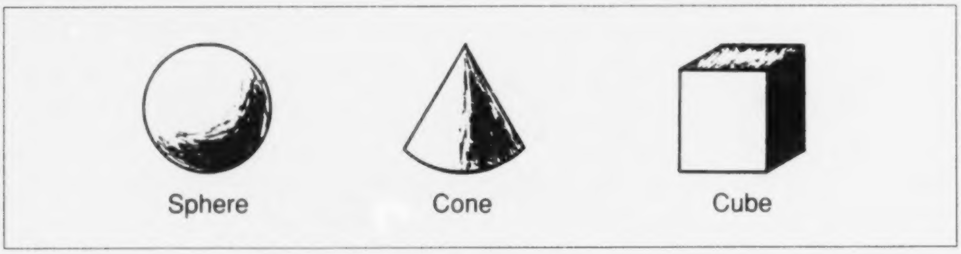
FIGURE 1



2. After the angle of the light source has been determined, all shading should be consistent with the direction and angle of the shadow produced by that source.

3. Any objective that is subjected to the light source should have a highlighted portion and a shaded portion. The shape and material content of the object determine the amount and the shape of the reflected light in the highlighted portion of the object. See Figure 2. Architectural building materials are normally shaded according to their texture. For example, a smooth surface—such as glass—will contain only a few lines of reflection, while a rough surface—such as brick—will be continuously shaded.

FIGURE 2

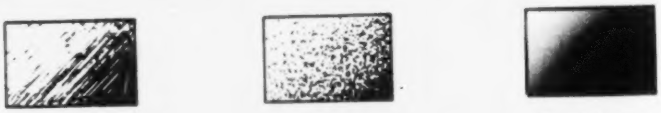


STUDENT SUPPLEMENT 2

4. The farther a surface is located from the light source, the darker that surface should appear.

5. Shading is accomplished through the use of lines, dots, or grey tones. See Figure 3.

FIGURE 3



Lines

Dots

Grey tone

Guidelines for using the various types of rendering techniques

1. Landscaping includes any of the following natural and man-made items:

   - Trees
   - Shrubs, hedges
   - Ground cover
   - Retaining walls
   - Fencing
   - Water fountains and other decorative items
   - Streams

   Landscaping in front of a structure should be shown in light linework; landscaping behind a structure should be shown in heavier linework. This technique creates visual impact without allowing the landscaping to detract from the structure itself.

2. Human figures should be drawn in simplified form so as not to overwhelm the other aspects of the drawing.

3. Automobiles and other vehicles should be placed in logical locations—such as on parking areas—to provide information concerning traffic patterns and to give a sense of activity in the building.

4. Depending on the building's function, there may be a number of objects the drafter might add. Some of these items include building signs, exterior lighting, and other structures in the area. The drafter should select these objects to enhance the drawing yet not allow their use to detract from the structure itself.

PRESENTATION TECHNIQUES
UNIT 11

ASSIGNMENT SHEET 1—DRAW A TWO-POINT EXTERIOR PERSPECTIVE

Name ______________________________ Score ______________

Introduction

A two-point perspective is the most commonly used type of presentation drawing for building exteriors. Utilizing two vanishing points, a two-point perspective will give an excellent visual representation of two adjacent sides of a building or other object. In this assignment sheet, you will practice drawing a two-point perspective for your fire-station project.

Exercise

Directions

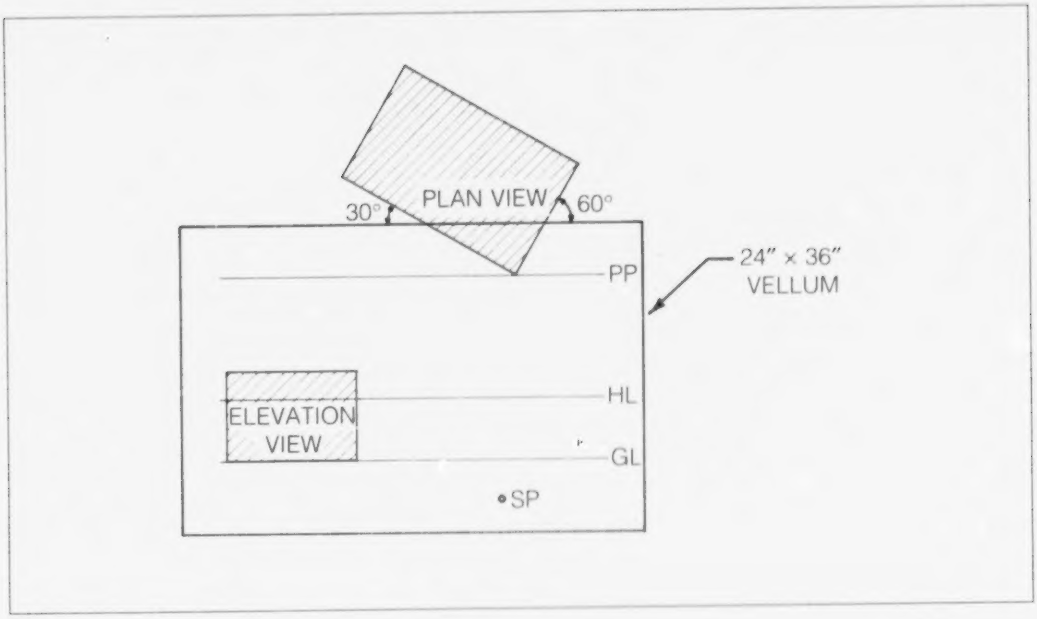
Study the information presented in Student Supplement 1 and the specifications for a two-point exterior perspective presented below. Then run a print of the floor plan and the front elevation plan you completed in Unit 4, Assignment Sheets 3 and 4. Complete a two-point perspective on a 24″ × 36″ (D-size) sheet of vellum.

Drawing specifications

- Draw a horizontal picture-plane line 3 inches down from the top of the vellum sheet.
- Place the floor-plan print onto the vellum so that the front-right corner of the building touches the picture-plane line and the front of the building is at a 30-degree angle to the picture-plane line.
- Place the front-elevation print in the lower-left portion of the vellum and extend a ground line out across the sheet.
- Locate the station point approximately 2 inches below the ground line and slightly to the left of the corner of the building located on the picture-plane line.
- Locate the horizon line 10′-0″ above the ground line. Make sure the drawing is set up similarly to Figure 1 on the following page.

ASSIGNMENT SHEET 1

FIGURE 1



- Project out from the station point lines that are parallel to the edges of the plan view. Project these two lines to the point where they meet the picture-plane line, then drop a vertical line from each point on the picture-plane line to the horizon line. These points become the two vanishing points you will use to create the perspective.

  NOTE: The right vanishing point may be located off the vellum. This is almost always the case in drawing perspectives.

- Create the two-point exterior perspective.

PRESENTATION TECHNIQUES
UNIT 11

ASSIGNMENT SHEET 2—RENDER DRAWINGS

Name ______________________________ Score ____________

Introduction

In this assignment sheet, you will practice using the rendering media you studied in Objective 5 of the information sheet.

Exercises

Part A — **Render an elevation plan**

Directions

Review the information presented in Student Supplement 2 and locate the front-elevation view of the fire station you used in Assignment Sheet 1 of this unit. Then trace the front-elevation view in the center of a clean sheet of D-size vellum. Use this tracing and drawing specifications given below to complete the rendering.

Drawing specifications

- Use a pencil to render the front-elevation tracing of the fire station.
- Assume the light source is sunlight coming from the upper-left corner of the vellum downward at a 45-degree angle.
- Apply shades, shadows, and texture wherever applicable.
- Add appropriate landscaping details.

Part B — **Practice using various rendering techniques and rendering media**

Directions

Locate the exterior perspective of the fire station you completed in Assignment Sheet 1, and run a print of the drawing. Use a variety of rendering techniques and media to render the perspective to include shades, shadows, texture, and landscaping. Then, on the blanks provided below, discuss which techniques and media you prefer most and why.

____

____

____

____

ASSIGNMENT SHEET 2

Part C **Render a presentation drawing for your portfolio**

Directions Locate the original of the two-point exterior perspective you completed in Assignment Sheet 1, and then render the perspective using the technique of your choice to create a completed presentation drawing for your portfolio.

PRESENTATION TECHNIQUES
UNIT 11

ASSIGNMENT SHEET 3—CONSTRUCT AN ARCHITECTURAL MODEL

Name ______________________________ Score ______________

Introduction Creating a scaled architectural model is the capstone of an entire project and requires a good amount of time and patience in completing. In this assignment sheet, you will practice constructing a scaled model of your fire-station project.

Exercise

Directions Review the working drawings you have completed in the fire-station project to determine a suitable scale for a model of the project and the proper architectural materials and their sizes. Fill in the blank below with the scale you have selected for your model, and list in the space provided below, the materials you will need to obtain to complete the model of the project. Then obtain the necessary materials and complete your scaled model of the fire station.

Scale selected ______________________________

Listing of materials necessary to complete model

PRESENTATION TECHNIQUES
UNIT 11

WRITTEN TEST

Name ______________________________ Score ______________

1. Match terms associated with presentation techniques to their correct definitions. Write the numbers on the blanks provided.

_______a. Condition created when a surface is not perpendicular to a light source

_______b. Extremely light wood used in making architectural models

_______c. Transparent vertical plane through which a plan view is projected in a perspective drawing

_______d. Compressed styrofoam material produced as sheets of varying thicknesses

_______e. Adding shade, color, shadow, texture, reference figures, landscaping, and other features to a drawing in order to give a more realistic perception of a structure

_______f. Transparent, water-based paint

_______g. Small, air-pressure-controlled paint gun

_______h. Compressed wood-fiber material produced as sheets of varying thicknesses

_______i. Condition created when light is excluded by a shaded surface

_______j. Pressure-sensitive, adhesive-backed transparent film used as transfer media

_______k. Figure used in drawings and models to relate the scale of a structure

_______l. Visual or tactile quality of a surface

_______m. Three-dimensional pictorial drawing made by projecting points through a fixed plane from a fixed point of observation

1. Air brush
2. Applique
3. Balsa wood
4. Picture plane
5. Foam core
6. Reference figure
7. Rendering
8. Shade
9. Shadow
10. Texture
11. Watercolor
12. Chipboard
13. Perspective

WRITTEN TEST

2. Define the term *presentation drawing*. Write your answer on the blanks provided beside the term below.

   Presentation drawing ____

   ____

   ____

3. Match types of presentation drawings to their correct definitions. Write the numbers on the blanks provided.

   _____a. Drawing developed by rendering an existing site plan to produce a plan view of a structure and its surroundings

   _____b. Vertical, two-dimensional view showing shape and design of each of the exterior or interior faces of a structure

   _____c. Perspective drawing that contains two vanishing points and positions the structure at an angle to the picture plane

   1. Elevation
   2. Site
   3. Two-point perspective

4. Match components of a perspective drawing to their correct descriptions. Write the numbers on the blanks provided.

   _____a. Assumed reference point of the observer's eye

   _____b. Line indicating observer's eye level above or below the ground line

   _____c. Vertical line of the plan view that touches the picture-plane line; appears as the actual height of the scaled drawing, with all other lines receding to the appropriate vanishing point

   _____d. Horizontal line representing the top edge of the picture plane; acts as the reference line from which all horizontal measurements of the perspective are determined

   _____e. Line representing the surface an object rests on; acts as the reference line from which the horizon line is determined

   _____f. Point on the horizon line at which receding lines appear to meet; acts as the point from which all non-height lines recede

   1. Horizon line
   2. Station point
   3. True-height line
   4. Picture-plane line
   5. Vanishing point
   6. Ground line

WRITTEN TEST

5. State common uses for types of rendering media. Write your answers on the blanks beside each of the terms below.

   a. Pencils ____

   ____

   b. Pen and ink ____________________________________

   ____

   c. Felt-tip markers ________________________________

   ____

   d. Watercolors ____________________________________

   ____

   e. Appliques ______________________________________

   ____

   f. Air brush ______________________________________

   ____

6. State uses for materials commonly used to construct architectural models. Write your answers on the blanks provided beside each of the terms below.

   a. ½- or ¾-inch plywood ____________________________

   ____

   b. ⅛- or 3/32-inch chipboard __________________________

   ____

   c. Cardboard, balsa-wood, foam-core sheets ________________

   ____

   d. Balsa-wood strips, toothpicks, dowels, heavy illustration board ______

   ____

   e. Clear plastic ____________________________________

   ____

WRITTEN TEST

f. Sandpaper ______________________________

____

g. Mixture of sand and paint ______________________________

____

h. Wire ______________________________

____

i. Dried twigs or weeds ______________________________

____

Glossary of Technical Terms

Admixture—Agent added to concrete mix immediately before or during mixing to alter one or more characteristic of the concrete mix (i.e., speed of hardening, thickness of mix, etc.)

Aggregate—Filler material used in concrete to provide volume at low cost

AIA—Abbreviation for *American Institute of Architects*

Air and water system—Cooling system in which air is passed over a water-chilled coil

Air brush—Small, air-pressure-controlled paint gun

Air chambers—Short sections of supply pipe that extend beyond last fitting on line; used to prevent water hammer

Air conditioner—Apparatus that can cool, clean, and circulate air

Air-conditioning—Controlling of temperature, humidity, ventilation, air motion, and air quality within a structure

Air system—Cooling system in which air is passed over cooling coils and then into rooms through diffusers

American Electricians' Handbook—Industry-recognized handbook used as a resource for standards and criteria concerning electrical applications in the construction industry

American wire gage (AWG)—Standard designation for wire of electrical conductors; the higher the designated number, the smaller the diameter of the wire

Ampere (amp, A, or I)—Measure of the intensity of electric current; rate at which 1 volt of electricity flows through a conductor with 1 ohm of resistance

Anchor bolt—Threaded rod inserted in masonry construction for anchoring the sill plate to the foundation

ANSI—Abbreviation for *American National Standards Institute*

Applique—Pressure-sensitive, adhesive-backed transparent film used as transfer media

Arch—Abbreviation for the word *architecture* or *architectural*

Architectural Graphic Standards—Industry-recognized handbook used as a resource for standard dimensions, construction methods, materials, and structural data

Architectural scale—Drafting tool that provides common fractional-inch scales (⅛", ¼", ½", 1/16") where fractional-inch increments represent a unit of measure equal to 1 foot in length

Architectural-symbol template—Drafting tool that provides to-scale templates for drawing door-swing, bathroom-fixture, kitchen-appliance, and cabinetry symbols

Architecture—The art and science of planning and designing buildings

Assn—Abbreviation for the word *association*

Backfill—Earth used to fill in areas around exterior foundation walls

Backflow preventers—Plumbing devices that stop the flow of water in the direction opposite its normal flow

Balsa wood—Extremely light wood used in making architectural models

Batt insulation (blanket insulation)—Insulating material usually composed of fiberglass, rock-wool, or cellulose material with or without a thin facing material, and made in relatively small units for convenience in handling and applying

Beam—Horizontal structural member that carries a load

Bearing wall—Wall supporting any vertical load other than its own weight

Bearing-wall superstructure—Superstructure comprised of continuous support walls normally made of masonry materials

Benchmark—Permanent reference point of known elevation from which other points can be measured

Bentonite clay—Highly absorptive and compressible clay material

Bibbs—Faucets or taps threaded so a hose may be attached to carry water

Bidding phase—Architectural work phase during which bids and negotiated proposals are sought as the basis for awarding construction contract

Boiler—Closed tank connected to an energy source that heats water to a high temperature

Bolts—Large cylindrical fasteners usually consisting of a piece of metal having a head or hooked end and a fully or partially threaded body

Branch circuit—Circuit that is a division of main feeder circuit; usually serves a specific location or function

Brick—Rectangular blocks made from clay or clay mixture molded into blocks and then hardened by drying in the sun or baking in a kiln (face brick, common brick)

Bridging—Wood or metal pieces fastened between timbers, such as floor joists, to distribute loads and strengthen the structure

Btu—Abbreviation for *British thermal unit*; amount of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit at a specified temperature (such as 39 degrees Fahrenheit)

Btuh—Abbreviation for *British thermal unit per hour*; unit of measure used to express hourly heat flow

Building drain—Drain that receives discharge from soil and waste pipes and carries it to building sewer branch

Building line—Established line on a property beyond which a structure may not extend

Building sewer branch—Large pipe that carries discharge from soil and waste pipes from building drain to public sewer

Built-up roofing (composition roofing)—Roof covering composed of layers of felt or plastic sheeting, hot-asphalt covering, and gravel or other aggregate; used to ensure a watertight seal on flat roofs

Busways—Large, heavy solid-copper or -aluminum bars surrounded by metal casing

Cable—Single-conductor wiring larger in size than no. 6 AWG, or two or more combined-conductor wiring of any size

Cable trays—Metal trays commonly hung from the ceiling with metal support brackets

Callout—Specific notation directed to a specific point on a drawing by a leader line

Canopy—Ornamental rooflike structure

Cellular decking—Light-gage metal sheets with channels used to form electrical raceways for running wiring, cabling, or conduit

Cement—Powder made from alumina, silica, lime, iron oxide, and magnesia burned together in a kiln and finely pulverized; an ingredient in concrete

Central system—Cooling system that is an integral part of the heating system and uses the same distribution system

Cfm—Abbreviation for *cubic feet per minute*; unit measure used to express air flow

Channels—Rectangular slots cut in concrete fill poured over structural-concrete slab floor; man-made ditches used to divert water runoff and minimize water flow to help prevent soil erosion

Chase (chaseway)—Vertical space within a building for ducts, pipes, and wires

Check valve—Valve that permits passage through a pipe in only one direction

Chipboard—Compressed wood-fiber material produced as sheets of varying thicknesses

Circuit—Completed path (loop) for electrical current to flow from source to destination and then back to source

Circuit breakers—Electro-mechanical devices containing a bimetal strip and a set of points; designed so that when excessive current flows through it, bimetal strip bends away from contact points and temporarily opens circuit until strip cools and again touches contact points

Civil engineers scale—Drafting tool that provides common scales (10', 20') where 1-inch increments represent a unit of measure equal to a given number of feet

Clay-tile product—Fired-clay product used for roofing, drainage pipe, and wall and floor finish material (structural clay tile, tile)

Cleanouts—Pipe fittings with removable plug placed at end of horizontal piping runs to allow access to waste-disposal system for cleaning and inspection

Co—Abbreviation for the word *company*

Column—Load-bearing vertical structural member with a height at least three times its largest diameter

Concrete—Building material made by mixing cement, sand and aggregates, admixtures, and water

Concrete block—Concrete-masonry units (CMUs) formed into modular sizes and shapes and used in constructing load-bearing walls, foundation walls, non-load-bearing partitions, and as a backup for other walls

Conductor—Material that permits a flow of electricity (electrons)

Conduit—Structurally supportive hollow galvanized-steel or polyvinyl-chloride (PVC) tubing in which wiring and cabling are run

Connectors and terminals—Devices attached to the ends of two or more conductors or cables to allow connection of electric current without permanent splices

Const—Abbreviation for the word *construction*

Construction documents—Composite of all working drawings and written specifications associated with a specific construction project

Contour line—Line on a drawing representing points of equal elevation

Contr—Abbreviation for the word *contract* or *contractor*

Contractor—Person or firm that undertakes responsibility for the performance of construction work

Convector—Surface designed to transfer its heat from a fluid to surrounding air, as in a steam- or water-heat system

Cornice—Exterior structural trim along intersection of roof and top of wall; includes all framing and trim members

Cornice detail—Detail drawn to show how exterior wall intersects structure's roofing system and any roof overhang that occurs at that intersection

Current—Movement or flow of electricity through a conductor

Cut and fill designations—Grading-plan component that consists of stake-like symbols with numerical indications representing the amount of earth to be removed from the existing site (cut) or added to the existing site (fill)

Cutting-plane line—Heavy broken line indicating plane at which a cross section is taken and the direction of viewing the object

Damper—Device used to regulate air flow

Damp-proofing materials—Materials that prevent the flow of groundwater into structural members (polyethylene sheeting, damp-proof coatings, bentonite-clay sheets, water repellant)

Datum line—Established reference line from which all other dimensions are taken

Dead loads—All permanent or unmovable parts of a structure

Decking—Light-gage metal sheets used to construct a floor or deck form, or used as floor or deck members; wood members used as finish surface of a deck

Detail—Large-scale graphic of part of another drawing, indicating special features of design, location, and composition and the correlation of the elements and materials shown

Diffuser—Register that emits air flow in a radial or fan-like pattern

Dimensioning—Recording on working drawing the specific sizes and locations of a structure and its components

Dimension line—Line indicating dimension of a part or member

Dimension lumber—Solid-wood members 2 to 5 inches thick and 2 inches or more wide (rough framing members, finished wood trim)

Direct system—Plumbing system in which water pumps are placed at lower and upper ends of building to provide water throughout structure at calculated quantities and pressure

Door and window detail—Detail drawn to show head, jamb, and sill details of any door or window

Double-line method—Method of drawing that shows a two-dimensional view of given object

Downspout—Pipe used to carry rainwater from the roof

Drainage components—Downspouts or drainage columns used to provide drainage for structures with flat roofs or to direct water on sloping roofs

Drainage-system materials—Pipes and panels used with channels or trenches to convey groundwater away from structure (perforated drain pipe, drainage panel)

Drain softener—Filtering system designed to remove sediment deposits from the main water supply

Duct—Rectangular or cylindrical sheet-metal-enclosed channel through which air is moved in an air-distribution system

Earth berms—Continuous embankments of earth that help control flooding and soil erosion during heavy rains and help reduce noise from outside sources

Easements—Rights of access onto another's property for specific purposes

Eave—Part of a roof, including the framing and trim members, that extends beyond the exterior wall line

Electrical-distribution panel (switchgear)—Enclosure that houses the main power source for a structure's electrical system

Electrical floor plan—Floor plan with electrical symbols showing exact location of switches, outlets, and electrical devices to accommodate appliances and fixtures; also lines that represent wiring from each switch to the connecting fixture

Electrical lighting plan—Plan showing the location of lighting-system components and information relating to those components

Electrical power-distribution plan—Plan showing the location and distribution of all power sources in a structure, excluding lighting

Electric-heat system—Heating system using an electric heater that produces heat by passing electrical current through resistive wires; heat is then dispersed by means of a fan or transferred to a sealed water supply

Elevation—Vertical two-dimensional view showing shape and design of each of the exterior or interior faces of a structure; vertical distance measured above or below an established reference point (such as sea level)

Engr—Abbreviation for the word *engineer*

Exhaust duct—Duct that is part of the system used to remove air from an enclosed area and discharge it into the atmosphere

Existing surveyed contours—Grading-plan component that consists of solid lines representing points of equal elevation and elevations representing a vertical distance above or below a referenced benchmark as surveyed on the initial site

Expansion joint—Separation between adjoining sections of a concrete slab to allow movement caused by expansion and contraction

Extension line—Line extending from object line to dimension line

Fascia—Horizontal trim member at lower end of roof rafters

Fastener—Mechanical device used to secure two or more members in position or to join two or more members

Feeder circuits—Wiring that runs from switchgear-room circuits to various electrical services throughout structure

Fillet—Concave junction formed where two surfaces meet; a narrow flat architectural member

Finish-floor elevation—Height of finish floor upon completion of structure

Firedoor—Door that will resist fire

Fitting—Standardized pipe shape that connects piping to the plumbing system

Fixture—Piece of equipment attached to plumbing piping system

Fixture branches—Slightly pitched horizontal pipes that carry waste water to main vertical waste stacks

Fixture unit—Measure of liquid flow in a plumbing system

Flashing—Pieces of sheet metal or plastic installed with exterior finish materials to prevent water from penetrating structure

Floor plan—Horizontal view of structure, showing length and breadth of structure and layout of rooms on that floor

Fluorescent-lamp lighting—Light source in which a phosphor coating transforms ultraviolet energy, produced by a discharge, into light; provides a general-use, diffuse light

Foam core—Compressed styrofoam material produced as sheets of varying thicknesses

Footing—Section of a foundation that supports and distributes structural loads directly to the soil

Footing detail (foundation detail)—Detail drawn to indicate dimensional information and material callouts concerning structure's foundation

Forced-air system—Heating system using a furnace to heat the air and fans and a system of supply ducts and branches, registers, and diffusers to circulate the warmed air throughout a structure

Forced-circulation hot-water system—Heating system using a boiler to heat water, a system of flexible tubing and narrow piping to circulate heated water throughout structure, and wall-mounted convectors that force out air heated by circulating hot water

Foundation plan—Horizontal view of entire substructure below first floor or frame of structure

Framed superstructure—Superstructure comprised of steel, concrete, or wood columns or posts to create support skeleton

Fresh-air duct—Duct that is part of the system used to vent fresh air into an air-distribution system

Furnace—Heating system in which heat is transferred from the point of combustion to the air supplied to the system; section of a boiler in which combustion occurs

Fuses—Tubes containing a soft-metal conductor; designed so that soft-metal conductor melts (burns out) and permanently opens circuit when excessive current flows through it

Gage—Thickness of sheet metal

Gage steel—Thin sheets of steel formed into various shapes and used as rigid structural members

Gas-piping system—Plumbing system in which pipes and valves or fittings are used to conduct natural or manufactured gas to fuel-burning plumbing fixtures

General notes—Statements of information concerning a drawing that are normally placed together but away from the linework

Glue-laminated timbers—Timbers created when two or more strips of wood are glued together to form a single wood member

Grade—Degree of inclination of a slope

Grade beam—Reinforced concrete beam placed at ground level; member supported by piles or piers at the end and intermediate positions

Grading plan—Drawing that shows the existing and proposed finish elevation of the earth's surface on a specific site

Gravel stop—Metal flange installed around perimeter of a built-up roof; used to retain gravel and prevent it from falling off a roof and to seal outside roof edge to prevent leaks

Gravity system—Plumbing system in which pumps placed in basement of building pump water into tanks placed at top of building and pressure is created when water flows downward by the force of gravity

Grille—Louvered plate usually found in an air-return opening

Ground line (GL)—Line representing the surface an object rests on; acts as the reference line from which the horizon line is determined

Groundwater—Water near the surface of the earth; water absorbed through the subsoil

Gutter—Trough along eaves to catch and carry off rain water

Head—Any horizontal upper member of a framed unit

Heating, ventilating, and air-conditioning (HVAC) **floor plan**—Floor plan with heating, ventilating, and air-conditioning symbols showing location and types of equipment, movement of hot and cold air, and location and size of ducts and diffusers

Heat pump—Heating and cooling unit; in winter it pumps heat from outside into the building; in summer it pumps heat from the building to outside

Heavy timbers—Square-sawn wood members 5 inches or more thick and 5 inches or more wide

High-intensity discharge (HID) **lighting**—Gas-discharge light source utilizing mercury, sodium, or metal halide gas; provides an intense light in lamp-type form

Horizon line (HL)—Line indicating observer's eye level above or below the ground line

HTF—Abbreviation for *heat-transfer factor*; value used to express heat flow (Btu's) through 1 square foot of a structural component at specific design conditions

Hydropneumatic system (compressed-air system)—Plumbing system in which a pump operates to keep a sealed tank filled with water to compress air trapped in tank at a desired pressure

Incandescent-bulb lighting—Light source in which a tungsten filament is heated to the point of illumination by an electrical current; provides a focused, direct light source

Inside design temperature—Temperature to be maintained within a structure

Insulated glass—Glass manufactured by separating layers of sheet glass with a ⅛- to 1-inch air space that is then sealed

Insulators—Materials that do not permit the free flow of electricity

Isometric drawing—Pictorial drawing in which all horizontal lines are drawn at a 30-degree angle from the horizontal and all vertical lines are drawn at a 90-degree angle from the horizontal

Jamb—Any vertical member on either side of a framed unit

Joist—Horizontal structural member used to support floor and ceiling loads in a building

Junction box—Container that protects conductor splices and provides support for electrical connections; designed to allow conductors to enter through knockouts in the sides and back

Kiln—Heated chamber used for firing brick and tile or drying timber

Laminated glass—Glass manufactured by bonding transparent vinyl between layers of sheet glass, resulting in a safety glass that adheres to the vinyl if broken

Laminated product—Material created when two or more surfaces have been glued together to form a single unit

Landscape template—Drafting tool that provides to-scale templates for drawing landscaping symbols such as trees, shrubs, fences, posts, and hedges

Lateral loads—External horizontal forces

Lien—Charge placed upon property until some debt is satisfied

Line intersection—Point where two lines meet

Lintel—Horizontal structural member above a door or window opening; used to distribute the weight from the structure above to both sides of the opening

Live loads—All movable bodies within a structure

Load-bearing—Supporting a load exerted from above

Longitudinal section—Complete-building section view in which cutting plane runs through entire length of structure

Loose-fill insulation—Insulating material manufactured as small granules or particles that are poured or blown into voids in floors, walls, or roofs

Lumber—Any material, such as boards, planks, or beams, cut from timber to a size and form suitable for marketing

Main water-supply line—Main supply pipe used to convey water into structure from community water system (street main)

Masonry—Construction involving assembly of a structure using individual units such as brick, block, stone, or tile bonded with mortar

Mass superstructure—Superstructure comprised of large amounts of materials over great area with little or no internal openings

Mechanical drawing—Drawing showing location and details about plumbing components and heating and air-conditioning units

Member—Structural component; single component of a series or set

Metal roofing—Roofing material composed of copper, aluminum, or galvanized iron; generally used for architectural style on more expensive structures

Millwork (architectural woodwork)—Wood construction products produced in a planing mill; includes trim molding, window and door frames, stairs, cabinets, and shelving

Modular—Fabricated based on a structural system that uses a 4-inch measurement for laying out the placement of structural members

Monolithic—Continuous mass of concrete cast as a single unit

Monolithic slab—Structural member consisting of a large, single piece of concrete

Mortar—Mixture of fine aggregate and cement paste used to fill voids between aggregate or masonry units and reinforce the structure

Nails—Fasteners consisting of a straight, slender piece of metal with one pointed end and one end that is struck with hammer or driven with pneumatic or powder-actuated gun (common nails, finish nails)

National Electrical Code—Handbook published by the National Fire Protection Association; sets forth minimum safety guidelines for electrical systems

Nosing (tread nosing)—Prominent extension of a stairway tread beyond the vertical face (riser) of a stair

Ohm (Ω or R)—Measure of electrical resistance; equal to the resistance encountered when 1 ampere of current is driven by 1 volt

Open circuit—Incomplete electrical circuit not allowing the flow of electricity

Open-web joists—Mass-produced structural-steel joists (trusses) formed from steel angles and steel rods and used in equally spaced arrays to provide support for floor loads and roof loads

Outlet—Destination point in wiring system at which the current can supply equipment requiring an electrical load

Outside design temperature—Calculated average temperature for a specific geographic location

Overhangs—Horizontal projections beyond the vertical face below; used to provide shade from the afternoon sun and to lend to the structure's overall appearance

Parapet walls—Low walls or short extensions above the finished roof line; used to hide mechanical equipment mounted on the roof, give structure a more impressive appearance, and help direct water drainage from the roof

Pattern glass—Glass produced with different surface designs that obscure vision but allow light transmission

Perspective—Three-dimensional pictorial drawing made by projecting points through a fixed plane from a fixed point of observation

Perspective drawing—Drawing having many of the features of a photograph; drawn by the architect to interest clients

Picture plane—Transparent vertical plane through which a plan view is projected in a perspective drawing

Picture-plane line (PP)—Horizontal line representing the top edge of the picture plane; acts as the reference line from which all horizontal measurements of the perspective are determined

Pier—Vertical support that provides bearing in the ground; functions similarly to a column

Piping plan—Working drawing detailing structure's water-distribution system

Plastic—Glazing product manufactured from clear or opaque synthetic materials

Plenum—Large chamber into which an air-handling system (heating or cooling) discharges air or returns air

Plot plan—Drawing that shows the top view of a site and indicates the placement of structures, utilities, easements, and other information necessary for construction

Plumbing floor plan—Floor plan with symbols representing location and type of fixtures, vents, valves, and pipe that will be installed in the structure

Plumbing plan—Working drawing detailing structure's waste-disposal system

Plumbing template—Drafting tool that provides to-scale templates for drawing standard plumbing symbols such as shower stalls, urinals, toilets, and water fountains

Plywood panels—Fabricated wood products manufactured from an odd number of wood sheets joined with glue

Precast concrete—Large sections of walls, floors, beams, or other structures formed and poured in other than their final position

Presentation drawing—Any of a number of drawing types that attempt to show a visual representation of a finished structure in its natural setting

Prestressed concrete—Building method in which stretched steel cables are put in tension and then concrete is placed over cables to form a concrete slab or other concrete structure

Prevailing-wind considerations—Climate-orientation considerations instituted either to accommodate or block the normal surface-wind directions associated with an area

Property survey (site plan)—Drawing that establishes specific boundaries, that provides information as to the exact location of a site, and that shows elevations, topography, and man-made features of the site

Proposed contours—Grading-plan component that consists of dashed lines representing the appearance of the site after grading

Purlin—Horizontal support that spans across adjacent beams

Raceway—Enclosed channel for routing and placing electrical conductors and cables

Radiator—Device that transfers heat from steam or hot water to the room air

Reference figure—Figure used in drawings and models to relate the scale of a structure

Register—Grille that contains a damper to help regulate air flow

Reinforcing bars (rebar)—Steel rods produced in various diameters and designed to be embedded in concrete to provide strength in tension

Rendering—Adding shade, color, shadow, texture, reference figures, landscaping, and other features to a drawing in order to give a more realistic perception of a structure

Resistance—Opposition offered by a substance to the passage of a steady electric current

Retaining walls—Concrete, brick, or railroad-tie walls built to hold earth on steep slopes

Rigid-sheet insulation—Insulating material manufactured in stiff sheets designed to be nailed or glued to the surface to be insulated

Riser—Any pipe that runs vertically to connect service branches or fixtures; vertical face of a stair from top to bottom

Riser diagram—Schematic drawing showing the floor-to-floor layout of electrical connections, conduit, circuit breakers, and other electrical equipment

Rockwool—Insulating material that looks like wool but is composed of substances such as granite or silica

Roofing shingles—Roof material composed of thin pieces of wood, asphalt-saturated felt, fiberglass, or other material; used primarily on sloping (pitched) roofs

R-value—Numeric value given as a measure of the effectiveness of a material's ability to resist heat transfer

Schedule—Listing or chart of parts (keyed to the plans), amounts, materials or products, and details

Schem—Abbreviation for the word *schematic*

Schematic design—Initial architectural work phase during which project requirements are determined and preliminary drawings are created

Screws—Wood or metal fasteners consisting of a tapered, threaded shank and a head designed to allow turning of the fastener

Section drawing—Cut-away view through an object or wall to show its interior makeup

Sediment ponds—Water basins that prevent soil sediment from entering sewers and/or waterways

Setback allowances (setbacks)—Required distances between a structure on a piece of property and the property lines at the front, side, and rear of the property

Shade—Condition created when a surface is not perpendicular to a light source

Shadow—Condition created when light is excluded by a shaded surface

Sheet glass (window glass)—Clear or opaque glass material manufactured in continuous, long flat pieces and cut to desired sizes and shapes

Shock absorbers—Devices in piping system used to reduce shock that occurs when water flow is suddenly obstructed

Short circuit—Connection of comparatively low resistance accidentally made between points on a circuit between which the resistance is normally much greater

Sill—Any horizontal bottom member of a framed unit

Sill detail—Detail drawn to show how structure's foundation wall connects to exterior outside wall and floor system

Single-line method (schematic drawing method)—Method of drawing that uses only one line to represent given object

Site—Building location

Site diagram—Drawing that defines the boundaries of the land on which a building is to be located

Site profile—Drawing showing section view of site, as though the earth were cut vertically

Slope—Upward or downward slant of land, or inclination or degree of that slant

Soffit—Exposed underside of an overhead component of a structure such as the underside of projecting rafter tails; lowered ceiling section such as over the top of wall cabinets

Soil stacks—Large vertical pipes that accept solid wastes from water closets and conducts it to building drain

Solar heat—Heat from the sun's rays

Solar-heat system—Heating system using a solar collector to capture sun's radiation and convert it to heat

Spec—Abbreviation for the word *specification*

Specifications—Set of precisely written documents that describe the contract parameters and quality of work to be performed during construction of a project

Stack—Vertical piping that serves as part of sewage-disposal system

Stairway detail—Detail drawn to show dimensional information concerning construction of a stairway

Station point (SP)—Assumed reference point of the observer's eye

Steam-heat system—Heating system using a boiler to create steam that is circulated through structure in a system of pipes and then to radiators that warm the air in each room

Stem wall—Vertical wall supported on a footing or other load-bearing surface

Stone masonry—Masonry product formed of natural rock (rubblestone, cut stone)

Stoop—Porch, platform, entrance stairway, or small veranda at a door

Structural drawing—Drawing by a structural engineer or architect; may accompany working plans and give important information about structure's foundation, skeleton, and floor systems

Structural steel shapes—Steel products produced in standard shapes (beams, angles, etc.) and sizes so that architects and engineers will be able to select members for construction that will result in good connections and a minimal waste of steel

Structural system—Weight-bearing frame of a structure

Substructure—Foundation that supports upper portion (superstructure) of a structure by transmitting loads down to soil

Superstructure—Any portion of a structure that rests upon the foundation (substructure)

Surfacing—Smoothing and truing the faces of a board

Swales—Depressions in the ground often designed for channeling surface water around a structure

Sweets Architectural Catalog File—Industry-recognized catalog file used as a resource for manufacturers' product information

Switch—Electrical device used to open or close a circuit

Tempered glass—Glass manufactured by reheating and then rapidly cooling cut glass, resulting in a glass that is much more resistant to thermal stress and impact

Texture—Visual or tactile quality of a surface

Thermal-radiation considerations—Climate-orientation considerations instituted either to accommodate or block the transmission of heat energy into a structure

Thermostat—Automatic temperature-sensitive device that opens and closes a circuit to regulate the temperature of an area

Tile roofing—Thin finish material made from cement or fired clay; used to create a different architectural style for sloping roofs

Tinted glass—Colored glass produced by adding small amounts of chemical elements to the molten glass mixture

Title—Instrument (deed) that is evidence of ownership

Transformer—Device designed to increase or decrease voltage or current of an alternating-current circuit

Transverse section—Complete-building section view in which cutting plane runs perpendicular to longitudinal cutting plane (the narrow width of the structure)

Traps—U-shaped fittings located near each fixture; retain water to act as a seal to prevent gases from backing up through fixture and into structure

Tread—Horizontal surface of a stair, including nosing

Troffer—Long, recessed light fixture with opening flush with ceiling

True-height line (THL)—Vertical line of the plan view that touches the picture-plane line; appears as the actual height of the scaled drawing, with all other lines receding to the appropriate vanishing point

Truss—Structural member constructed of components commonly placed in a triangular arrangement

Two-point perspective—Perspective drawing that contains two vanishing points and positions the structure at an angle to the picture plane

Uniform Building Code (UBC)—Manual of design and construction criteria established by the International Conference of Building Officials and used by regional building departments as a guide for the approval of architectural plans and specifications

Uniform Mechanical Code (UMC)—Manual established by the International Conference of Building Officials and used as a resource for standards and installation guidelines pertaining to mechanical systems

Uniform Plumbing Code (UPC)—Manual established by the International Association of Plumbing and Mechanical Officials and used as a resource for standards and installation guidelines pertaining to plumbing systems

Unitary system—Cooling system that is separate from the heating system and uses its own distribution system

Valves—Control devices for regulating flow of water

Vanishing point (VP)—Point on the horizon line at which receding lines appear to meet; acts as the point from which all non-height lines recede

Veneer—Thin layer of any building material used as a facing to cover a base layer (core) of another material; non-load-bearing exterior surface

Vent stacks—Vertical pipes extending above building to allow air flow into waste piping

Vestibule—Passageway, hall, or room between the outer door and the interior of a building

Vicinity map—Small illustration showing a structure's location relative to streets and/or other major landmarks.

Void—Open area

Volt (V or E)—Measure of electrical pressure; equal to the electrical force applied to move the current of 1 ampere over a resistance of 1 ohm

Wall section—Section view in which cutting plane runs through a wall from the top of the roof to the bottom of the foundation

Waste-disposal system (drainage, waste, and vent [DWV] system)—Venting system and collection of pipes and drains that conduct solid and liquid wastes from structure to public sewer line

Waste stacks—Large vertical pipes that accept liquid waste from fixtures not receiving solid waste (sinks, water fountains, lavatories) and discharges it into soil pipe or building drain

Watercolor—Transparent, water-based paint

Water-distribution system—Collection of supply pipes that conduct water from water main to structure's plumbing fixtures

Water meter—Device used to measure volume of water passing through main water-supply line at entrance to structure

Water system—Cooling system in which chilled water is circulated through a coil over which room air passes

Water table—Upper limit of the portion of the ground that is saturated with water

Watt—Measure of electrical power equal to amps multiplied by volts; equal to 1 ampere of current flowing with an electromotive force of 1 volt

Weld—Method of using high electrical voltage to create intense heat that then bonds a steel welding rod to structural members to be joined

Welded wire fabric—Square grids formed of wire fabric and used to provide tension strength when embedded in concrete-slab floors

Wire—Single-conductor wiring no larger in size than no. 8 AWG

Wired glass (wire glass)—Glass in which wire mesh is embedded between two layers of sheet glass, resulting in a safety glass that prevents the glass from shattering if broken

Working drawings—Set of detailed drawings or plans drawn to scale by a drafter; shows all information and dimensions necessary to build or remodel a structure